J. Wilson Spaeth

JOURNAL *of* FORESTRY

April
1932

Vol. XXX Number 4

SOCIETY OF AMERICAN FORESTERS 1900

Published by the
SOCIETY of AMERICAN FORESTERS

Single Copy Sixty Five Cents Four Dollars per Year

JOURNAL of FORESTRY

OFFICIAL ORGAN OF THE SOCIETY OF AMERICAN FORESTERS

A professional journal devoted to all branches of forestry

Entered as second-class matter at the post-office at Washington, D. C.

Acceptance for mailing at special rate of postage provided for in the Act of February 28, 1925, embodied in paragraph 4, Section 412, P. L. and R. authorized November 10, 1927.

Office of Publication, Room 810, Hill Bldg., 839 17th St., N. W., Washington, D. C.

Editorial Office, 231 Giannini Hall, Berkeley, California—Manuscripts intended for publication should be sent to Emanuel Fritz, Editor-in-Chief, at this address, or to any member of the Editorial Staff.

The JOURNAL appears eight times a year monthly—with the exception of June, July, August, and September.

The pages of the JOURNAL are open to members and non-members of the Society.

Missing numbers will be replaced without charge, provided claim is made within thirty days after date of the following issue.

Subscriptions, advertising, and other business matters should be sent to the JOURNAL OF FORESTRY, Room 810, Hill Bldg., 839 17th St., N. W., Washington, D. C.

CONTENTS

JOURNAL OF FORESTRY

Vol. XXX APRIL, 1932 No. 4

The Society is not responsible, as a body, for the facts and opinions advanced in the papers published by it. Editorials are by the Editor-in-Chief unless otherwise indicated and do not necessarily represent the opinion of the Society as a whole. The "leaders" preceding major articles are to be regarded as editorial additions.

EDITORIAL

Ponderosa Pine, Douglasfir and Balsam Firs
Let's Settle their Nomenclature

HENCEFORTH, *Pinus ponderosa,* over whose common and commercial nomenclature there has been so much argument and litigation, is to be known officially as "ponderosa pine." No longer will the government insist on calling it western yellow pine as stubbornly as the manufacturers have clung to such names as California white pine, Arizona white pine, and others of a like nature. Both were inept. The botanical kinship of the ponderosa pine to the hard and heavy yellow pines of the southeastern forests has given many people erroneous conceptions of the character of its wood and has caused the lumber producers no end of loss and worry. Since the Federal Trade Commission has ordered the discontinuance of existing objectionable trade names the industry has united to call the tree and wood ponderosa pine. And now the Forest Service officially relegates its own name to the unpleasant past and joins hands with the lumbermen on the name ponderosa pine. No good will come from a continued use of the old name western yellow pine by unattached foresters, botanists and others. All should now unite on the one name—ponderosa pine—for the tree and the wood. The Journal of Forestry will adopt this name as its standard and all manuscripts not already in type will be changed in agreement.

The Forest Service decided to apply the new name, ponderosa pine, to designate also the wood of Jeffrey pine (*P. jeffreyi*) but not the tree. Just why is not quite clear. It does not seem to have been necessary, although it might obviate possible trade difficulties. There is not much Jeffrey pine, but its wood is sufficiently different from that of *P. ponderosa* to merit its heretofore distinctive separate name. It is in general so much softer, more homogenous, and less conspicuously figured, that it should command a premium if a company had enough of it to market it separately.

While we are on nomenclature why not consider also a modification of the name of Douglas fir? This is another designation that causes much confusion in the trade. The wood is still called Oregon pine in the California and the export trade, while horticulturists call the tree Douglas spruce, and scientists know it by the atrocious name of *Pseudotsuga* (false hemlock). The tree is neither a pine, spruce, fir nor hemlock, and the wood, while it resembles that of a hard pine, is only very remotely like that of fir,

spruce or hemlock. Our English language has just failed to develop a distinctive term for it as it has for the more or less similar (and yet very different as to properties) woods beech, birch and maple. To continue the double name Douglas fir is libelous to a superior tree and wood—it is not *any* kind of fir. In trade, dishonest salesmen have been known to take advantage of the binomial—speaking only of "fir," quoting the price of a true fir and shipping a true fir, but all the while leaving the buyer with the impression that he is to get Douglas fir. As long as the binominal exists there will be a tendency to drop the prefix "Douglas" with resultant trouble and confusion, particularly since we refer to the genus Abies as true fir and thus create the inference that Douglas fir is a substitute fir. The name Douglas fir is already too well established to drop it easily for another. But why not shorten it to a one-syllable word "douglasfir" and perhaps spell it with a lower case "d"?

Then why not consider also the possibility of doing something about "true fir" to distinguish the species of Abies from Pseudotsuga? Why "true" fir? Is there a "false" fir? The suggestion has been made that the term "balsam firs" be applied to all species of Abies as a group designation, just as now we group pines as white pines and yellow pines.

These suggestions have been passed on to the nomenclature committee of the Forest Service, and have been given the promise of consideration. Doubtless it would welcome criticism for or against the changes from those interested.

TRANSPIRATION CAPACITY OF CONIFEROUS SEEDLINGS AND THE PROBLEM OF HEAT INJURY

By JACOB ROESER, JR.

Rocky Mountain Experiment Station, Colorado Springs, Colo.

The author, who has previously published the results of direct tests showing the comparative ability of seedlings to stand excessive heat, here attempts to bring out a possible relationship between heat resistance and transpiration capacities of seedlings of different species. This, naturally, is based on the assumption that the passage of the water stream through the stems, and its evaporation from the leaves may have a cooling effect which tends to offer protection to the seedling. The field has proven a difficult one for satisfactory experiment.

SILVICULTURAL experience has indicated that the ability to withstand excessive heating plays an important part not only in determining the amount of reproduction which may start on a given insolated site, but also the species which may occupy the site.

Through a period of nine years, from 1920 to 1928, several tests were conducted at the Fremont Field Station near Colorado Springs to determine not only whether the important coniferous species of the Central Rocky Mountain region exhibit different degrees of resistance to excessive heat as young seedlings, but also the extent to which this resistance is influenced by the amount of moisture available to the roots.

The first phase of these tests, dealing with the effect of combined heating and drying, was reported on December 1, 1920 (5). The value of the results obtained were to a considerable extent vitiated by errors in technique.

The results of the more satisfactory 1922 series of tests, in which the moisture factor was eliminated, are outlined in Dept. of Agri. Bulletin No. 1263 (3). Lodgepole and western yellow pine seedlings were found more tolerant to high temperatures than Engelmann spruce and the Rocky Mountain form of Douglas fir.

Subsequent tests were made to check these early results and to study (a) resistance to the more common form of stem injury which results from contact with a superheated soil surface—the "ground level constriction" described by Baker (1)—as distinguished from leaf injury under direct radiation which is inevitably associated with water loss and (b) more specifically, the transpiration capacities of the various important indigenous species under different degrees of heat exposure.

Stem Resistance to Excessive Heat

Since this phase of the problem constitutes the primary object of the experiment as it was originally conceived, it will be discussed first. The initial series of tests in which the stems of seedlings were directly subjected to critical temperatures was conducted in 1926 and the second in 1928. In the former, the seedlings used were from seed sown 58 and 110 days previous, with the exception of those of Douglas fir, which were 19 days younger. In the latter, 71-day-old seedlings were used. In the discussion of all tests, the age of seedlings is calculated from the date of sowing, which, while appearing to be an illogical usage of the term, ties the age to a definite date, which it was impractical to determine for each seedling as it germinated. The actual age of all seedlings, starting from the time

of appearance above the ground, may be considered two to three weeks less than the quoted age.

The procedure employed in these tests was as follows: Ten seedlings of each of the four species, western yellow pine (*Pinus ponderosa*); lodgepole pine (*Pinus contorta*); Douglas fir (*Pseudotsuga taxifolia*, var. *glauca*); and Engelmann spruce (*Picea engelmannii*) were threaded through a thin board so that the roots hung freely in water. The seedlings were held in place by packing the openings in the board with cotton. A quantity of dry Nebraska dune sand was heated and sprinkled quickly and uniformly over the board to a depth of ¼ inch. A thin-bulbed thermometer recorded effective temperatures at the surface of the board. While the maximum temperature, no doubt, varied at different points on the board, it is believed that the promiscuous distribution of the seedlings provided an equitable basis for comparing the different species. Five minutes after application of the sand the seedlings were removed, promptly planted in moist sand, and subsequently observed from time to time.

RESULTS

The immedate evidence of injury upon subjection to the hot sand treatment consisted in lesions which constricted the stem at the ground line. These strictures varied in length up to 0.4 inch, their severity depending upon the succulence of the stem and the species. They appeared to be most severe in western yellow pine. Rapid lignification of stem tissue is the best defense against this form of injury. With western yellow pine only were the strictures severe enough to cause immediate collapse, but this may be attributed to the greater weight of the western yellow pine tops, since lodgepole pine and Douglas fir seemed almost as badly injured. The strictures were less evident in Engelmann spruce, probably because of greater rigidity of stem tissue,[1] but subsequent results indicated that similar but less obvious injuries had been incurred.

As a rule, no general change in condition was to be noted in the seedlings for five days after treatment, and where the injury was not severe no change, even in length of stricture, was noted. The steps preceding death varied with the species, the severity of injury and presumably, the susceptibility to fungus attack (4). Ordinarily in western yellow pine shrivelling of the stem progressed upward from the stricture, and the leaves wilted gradually as the result of the stoppage of water movement until the crown was completely dried. No loss of color accompanied this process. Engelmann spruce and lodgepole reacted similarly, but the upward extension of the strictures was less pronounced because of shorter and smaller stems, and perhaps, because of a higher percentage of lignified tissue. Engelmann spruce shriveled as a rule more rapidly than the pines.

Injured Douglas fir stems appear more likely to be attacked by fungi at the point of stricture than are those of the three other species. When this condition occurred, the strictured stem rapidly contracted to approximately one-fourth its original diameter. The cotyledons began to curl upwards and inwards, at the same time turning a dull brownish green. In a very short while total decay had destroyed the plant, including the root.

Twelve separate tests were made for the 58 to 110-day old classes of seedlings in 1926, involving maximum temperatures varying between 97.7° F. and 163° F. for the younger, and 111.2° and 191.8° F. for the older seedlings. In 1928, twenty-one tests were carried out with seedlings of western yellow pine and Douglas fir;

[1]Seedlings of this species seldom collapse, if more than a few days old, when killed by any injury.

14 with lodgepole pine and 10 with Engelmann spruce, all 71 days old. The final survival percentages were curved, and from these curves the data presented in Table 1 were read.

In general, it may be said that the relative resistance of seedling stems increases with increasing age, at least, at temperatures high enough to cause appreciable loss. Temperatures up to 120° F. seem unlikely to cause stem injury to seedlings of any of the four species. Above this, resistance varies with species, being greatest for western yellow pine, and least, apparently for lodgepole, which is represented by the smallest seedlings. The effect of lignification of stem tissue with aging is apparent in all species but Douglas fir. It is most pronounced in lodgepole pine and least so in Douglas fir, where the minimum temperature causing 100 per cent loss is approximately the same for all ages of seedlings. While this result is probably due to the use of a poorer class of older seedlings, it is known that, in spite of a fairly stout stem, this species is the slowest in developing protective tissue during the first year and most quickly succumbs to stricture injury.

At 110 days, both pines show themselves more resistant than Douglas fir and Engelmann spruce with the limit of complete safety advanced to about 131° F. At this age the most resistant western yellow and lodgepole pine seedlings appear to be able to withstand instantaneous temperatures of approximately 180° F. For Engelmann spruce, the limit is around 167° F., and for Douglas fir (91 days old) it is probably little, if any, above that for 72-day-old seedlings. The rather wide range for lodgepole between initial and complete loss at 110 days reflects to some extent the erratic germination habit of this species, and the resulting weakness of the method of determining seedling age here used.

The difference in age of two weeks between the youngest and the intermediate-aged seedlings seemed to account for an increase in resistance equivalent to about 10° F. for western yellow pine, 9° for lodgepole, 2° for Engelmann spruce, and 1.5° F. for Douglas fir. These increases are augmented to 18°, 26°, and 16° for the first three species at the time of the last test, involving seedlings 110 days old, while for Douglas fir, the data indicate that this species fails to improve its capacity for resistance.

Table 1

TEMPERATURES AT SEEDLING STEMS WHICH ARE TOLERATED, AND FATAL, AT DIFFERENT AGES, IN DEGREES FAHR.

CURVED VALUES BASED ON 22 TO 33 TESTS WITH EACH SPECIES, 1926 AND 1928, OF 10 SEEDLINGS EACH

Species	Age of seedlings (days)	Temperature: Highest likely to be tolerated by all individuals	Temperature: Likely to be fatal to all	Temperature: Range expressing individual differences
Western yellow pine	58	122	158	36
Lodgepole pine	58	124	138	14
Douglas fir	39	125	150	25
Engelmann spruce	58	123	145	22
Western yellow pine	71	133	168	35
Lodgepole pine	71	128	152	24
Douglas fir	71	124	154	30
Engelmann spruce	71	120	152	32
Western yellow pine	110	136	182	46
Lodgepole pine	110	132	181	49
Douglas fir	91	131	146	15
Engelmann spruce	110	133	167	34

The results suggest that protection against heat injury to stems is not so much a matter of physiological resistance as one of morphological habit and development by adaptation to the natural conditions to which the seedlings are exposed. Although the results show a good deal of dispersion, which may be expected because of individual variation in seedling development, errors in technique and limited data, they show that western yellow pine, a species which habitually occupies warm and dry sites, develops the greatest average resistance to this kind of injury, even at an early age. Although stem lesions are apparently rather readily produced, the conductive elements within the relatively large stem probably remain open, and wilting does not occur immediately. Probably the most important factor in the protection of seedlings of this species is stem size and rapid development of insulating tissue, both naturally and where superficial lesions have been made. Douglas fir stands at the other extreme and its case has been discussed. Any development of this species under conditions of intense insolation seems impossible. The relative degree of initial injury to spruce stems is not always readily apparent, since, of all the species tested, it is the one least likely to show by collapse that the stem has been fatally injured. This may indicate that the stems of this species are less succulent and more resistant than those of lodgepole pine at an early age. The latter represents somewhat of a paradox for while it quickly develops a degree of resistance comparable to that of western yellow pine (110 days old), it is apparently least able to withstand excessive temperatures in early life (58 days old).

Surface temperatures as high as 158° F. have been recorded on exposed south slopes in the Central Rocky Mountains. Bearing in mind that western yellow pine is the only one of the four indigenous species represented in the experiment which at an early seedling stage may be

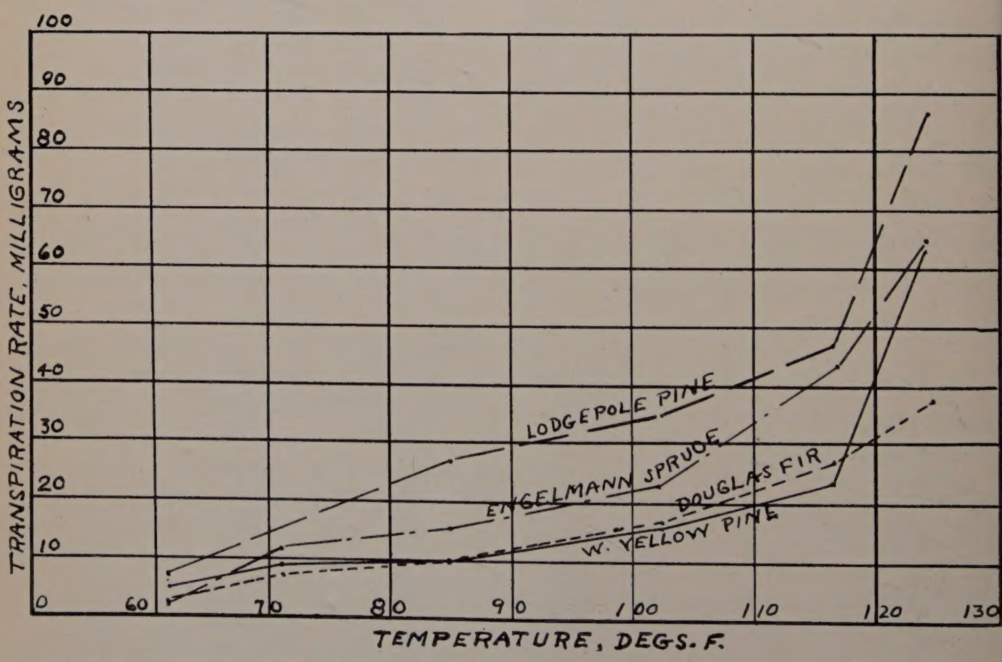

Fig. 1.—Transpiration rates at moderate temperatures in milligrams per minute per gram of seedling dry-weight.

expected to show any survival at all at this temperature, it is clear why it is the natural occupant of these sites (within its altitudinal range) and why it is difficult to procure natural reproduction even of this species, especially when its poor seeding habit is also considered. Certainly Douglas fir, with rooting vigor comparable to that of western yellow pine, can hardly be expected to replace the pine, and any survival of this species must be secured under protection. Therefore, it may be concluded that high surface temperatures are an important factor in delimiting the natural habitats at least of these two species.

Absolute and Relative Transpiration Under Exposure to Excessive Temperatures

The results obtained in the early laboratory tests of excessive heating and critical temperatures in which both western yellow and lodgepole pine exhibited a greater degree of resistance than was shown by Douglas fir and Engelmann spruce, led to the assumption that this quality may depend as much upon transpiration capacity as upon morphological structure of the stem and perhaps of the leaves. The ability of any seedling to survive when excessive heat is applied more directly to the leaves would appear to be intimately related to the capacity of its cells to remain below the air temperature, and this capacity evidently varies according to the absorptive nature of the cell walls and plastids and the rate at which heat it dissipated by vaporization and transpiration.

Bates (2) states that spruce transpires less than the pines both on the basis of increment and leaf exposure, and the assumption is, that while this quality is of vital importance to the species under conditions of very limited available moisture, it may, on the other hand, signify that spruce can not accommodate itself as

Table 2

DATA ON SEEDLINGS EMPLOYED IN TRANSPIRATION TESTS, 1928

Test	Average air temperature (F)	Temperature extremes (F)	Duration exposure (min.)	Relative humidity per cent	Average dry weights (mg.)				Dry weight extremes (mg.)				Ratio of dry weight to green weight (per cent)			
					Western yellow pine	Lodgepole pine	Douglas fir	Engelmann spruce	Western yellow pine	Lodgepole pine	Douglas fir	Engelmann spruce	Western yellow pine	Lodgepole pine	Douglas fir	Engelmann spruce
1	61.2	60.7– 64.5	1500	94												
2	70.8	67.0– 76.5	1320	66	34.0	11.0	18.0	7.4	29–39	7–14	13–23	6–8.5	19.8	19.9	20.9	33.1
3	85.0	83.0– 87.0	540	44												
4	103.1	96.8–109.4	975	51	23.5	14.5	19.8	8.2	17–34	9–17	17–21	8–9	22.0	29.1	26.2	40.2
5	116.2	114.1–118.2	480	43												
6	124.1	120.6–127.4	120	48	30.8	14.8	20.0	6.2	26–38	13–16	16–24	6–7	26.5	34.7	25.3	34.7

readily as can the pines to conditions which demand quick and adequate absorption to meet the demands of excessive transpiration. To some extent this condition is met by modification in leaf structure, involving shape and arrangement of stomata. The question then resolves itself into whether the seedlings of different species are protected in different degrees by their varying transpiration rates and whether this variation is sufficiently pronounced to be regarded as a factor of importance in the dissimilar heat tolerances of the four species.

The first tests in this phase of the experiment were made in 1923 and 1924, but were inadequate to provide the basis of any very definite conclusions.

In two later series of tests made in 1925 and 1928 transpiration loss was determined by weighing, a method which was originally passed up since it was thought that sufficiently precise determinations could not be made for very brief exposures. It is believed, however, that the necessary precision was obtained by using a pulp balance, weighing to milligrams. In discussing the results obtained in these two series, the one of 1928, which permitted of more definite interpretation, is first considered.

TRANSPIRATION AT NON-CRITICAL TEMPERATURES

The purpose of these tests was not to get a measure of maximum transpiration rates, but to study the degree of acceleration induced by gradually increasing the heat to which the seedlings were exposed and which they may be expected to encounter under natural conditions.

Six distinct tests were carried out in the 1928 series. Four representative seedlings each of western yellow pine, lodgepole pine, Douglas fir and Engelmann spruce were placed in narrow-mouthed bottles holding about 150 c.c. of water, so that the roots were entirely submerged and the aerial portion exposed above a split cork which held the seedling in place. Such batteries of sixteen bottles

TABLE 3

TOTAL AMOUNT AND RATE OF TRANSPIRATION OF CONIFEROUS SEEDLINGS AT AVERAGE AND MODERATELY HIGH TEMPERATURES, IN 1928 TESTS

(Each entry represents the average for four trees)

Number and description of test	Datum[1]	Western yellow pine	Lodgepole pine	Douglas fir	Engelmann spruce
1 61.2° F.	Amount	24.1	10.2	5.1	2.5
1500 mns.	Rate	4.7	7.0	2.1	2.3
2 70.8° F.	Amount	38.2	19.5	16.6	11.1
1320 mns.	Rate	8.6	14.6	7.4	11.7
3 85.0° F.	Amount	17.4	15.4	9.1	5.9
540 mns.	Rate	9.6	27.0	10.0	15.6
4 103.1° F.	Amount	36.0	50.2	33.8	18.8
975 mns.	Rate	16.5	35.0	17.2	23.2
5 116.2° F.	Amount	26.5	31.2	26.2	17.1
480 mns.	Rate	23.6	47.5	27.8	43.6
6 124.1° F.	Amount	22.2	14.8	9.0	4.8
120 mns.	Rate	62.4	86.6	38.4	65.0

[1]Amount=total quantity transpired in milligrams.
Rate=loss per minute per gram of dry weight expressed in milligrams.

were subjected to six different temperatures up to 124.1° F. for periods varying from 2 to 25 hours. For the higher temperatures the time was reduced to periods through which the seedlings might be expected to pass without suffering injury which might interfere with transpiration. Temperature readings were obtained by means of a mercurial thermometer whose bulb was placed at the level of the leaves of the seedlings and moved in position from time to time to obtain various exposures. Readings were made at half-hour intervals for the shorter exposures, and, except when the tests ran through the night, at one-hour intervals for the longer exposures. In all tests, the seedlings were illuminated by a sixty-watt lamp, so that the light factor was constant for all exposures.

The six exposures are as given in Table 2. The desired low temperature for Test 1 could only be obtained under a condition of high humidity, and the transpiration rates in this test, as shown in Table 2, are lowest and express a condition of relative transpirative quiescence.

Three sets of seedlings were employed, one for Tests 4 and 5, another for Tests 1, 2 and 3, and a third for Test 6. The average dry weights of the seedlings, which were 71 to 75 days old, are also shown in Table 2. Each group represents four seedlings.

Considerable variation existed in the weights of the seedlings used in the several tests despite diligence in selecting stock of fairly uniform size. Variations in the ratio of dry to green weights are due largely to the fact that it was not possible nor desirable to remove all surface water from the seedlings. The differences make it desirable to calculate transpiration values on the basis of dry rather than green weight.

The average total water loss in milligrams and the rate of transpiration in thousandths of milligrams are given in Table 3. The rates per minute are illustrated in Figure 1.

Referring to Table 3 it will be seen that both western yellow pine and lodgepole pine transpired more per tree than Douglas fir and Engelmann spruce in all of the tests, although in Tests 4 and 5 the values for Douglas fir closely approached those for western yellow pine for which the seedlings were smaller than usual. At the same temperatures, the small lodgepole seedlings transpired considerably more than the western yellow pine plants of nearly twice their size.

In rate of transpiration, based upon dry weight, lodgepole pine far outstripped the other species. At the higher temperatures, spruce followed lodgepole and was in turn followed by Douglas fir and western yellow pine whose values closely approximated each other. At the lowest temperature, the last-named ranked immediately behind lodgepole. The situation with lodgepole is rather striking, in view of the difference in natural habitat preferences of this species and yellow pine and in root system development which permits the latter to penetrate rapidly

Table 4

RELATIVE RATES OF TRANSPIRATION INCREASE WITH TEMPERATURE

Test	Temperature	Duration	Western yellow pine	Lodgepole pine	Douglas fir	Engelmann spruce
			Transpiration rate relative to that at 61.2° F., times			
1	61.2° F.	1500 min.	1	1	1	1
2	70.8° F.	1320 min.	1.83	2.09	3.52	5.08
3	85.0° F.	540 min.	2.04	3.76	4.76	6.78
4	103.1° F.	975 min.	3.51	5.00	8.19	10.08
5	116.2° F.	480 min.	5.02	6.79	13.24	18.96
6	124.1° F.	120 min.	13.28	12.37	18.37	28.26

into the soil and avail itself of the moisture needed to satisfy its transpiration demands.

Douglas fir showed a much smaller increase in transpiration in comparison with the other species at the highest temperature (124.1°) but because no experimental data are at hand for temperatures above 124°, too much weight should not be placed on the figure for this species as an expression of its behavior under conditions approaching the critical. This result, however, supports conclusions based on past tests and upon fairly intimate knowledge of the tree's reactions when abnormally heated.

While these data present a fairly clear picture of transpiration per se, without amplification they do not provide a very clear comparison of the manner in which the various species respond to meet the transpiration demands of higher temperatures. Perhaps the simplest and most reasonable way to illustrate this is to compare for each species the rate of transpiration in tests 2-6 with that of Test 1. The results are shown in Table 4.

These data show that both Engelmann spruce and Douglas fir apparently are more capable of increasing their rate of transpiration under severe but not critical conditions of heat exposure through protracted periods than are the pines, which respond quite similarly through the scale. To what extent the time factor is significant in this reaction has not been determined. At ordinary temperatures, it is not likely that it plays an important role. Possibly the short duration of the 124-degree test explains in part the high rate attained, which meant for the 2-hour period that lodgepole pine seedlings transpired about three times their own green weights and ten times their dry weights.

While Douglas fir and spruce show a progressively higher ratio with temperature increase, the fact that the proportionate increase between 116.2 and 124.1° for these species is less than for the pines, especially western yellow pine, may be of some import. To obtain more enlightenment on this particular point, the results of the 1925 series of tests are presented.

TRANSPIRATION AT CRITICAL TEMPERATURES

In the 1925 series, three classes of seedlings were tested: namely, 68 days old (Douglas fir, 42), 122 days old (Douglas fir, 96), and approximately one year old. The technique employed in testing consisted in placing the seedling roots in small bottles 2″ high, 9/16″ in diameter, with a 3/16″ orifice and filled with distilled water; stopping the mouths of the bottles with cotton, and placing them under a thin board so perforated that the seedlings could be exposed through ⅛″ holes. The board protected the bottles from direct insolation.

An electric coil was used as the source of heat. Maximum temperatures were read from a maximum-recording thermometer, the bulb of which was held in a position of average exposure. Each bottle with its seedling was weighed immediately prior to and following each test. Two seedlings each of western yellow pine, lodgepole pine, Douglas fir and Engelmann spruce in each age class, a total of 8, were exposed in each test, and all quantities in Table 5, unless otherwise indicated by a figure within a circle, represent the average loss in weight through transpiration for two seedlings, admittedly a very small number for reliable results.

Each age-test series involved from eight to eleven exposures, not including one extending over a relatively long period at room temperature. The period of exposure falls into one of three general groups; 15 (20 mins. for one-year-old seedlings), 30 and 60 minutes. An attempt was made to regulate the heat, so that the same maximum temperatures

might be applied for each of the three periods. This was usually not accomplished very closely, as seen by reference to the actual maxima given in Table 5, where it is seen that there was generally a tendency in each group of tests for the temperatures to go higher with the longer exposures. This indicates that the maximum was probably reached close to the end of each exposure, at least with the shorter ones.

During the progress of each test, the seedlings were carefully observed and as soon as any showed signs of serious injury or collapse, the bottle was removed and weighed and the time of exposure recorded. It was necessary to do this in a few cases at some of the highest temperatures, but in all but one case the period of exposure did not vary more than two minutes from any of the three standard exposures. The exception involved an exposure of 122-day-old spruces at 166.8° for 38½ minutes, and this is included in the 30 minute group. In the very few cases in which a seedling was injured or scorched to the extent that its transpiration equivalent might be questioned, it was dropped from consideration.

The average rate of transpiration per minute per gram of dry weight is shown for all tests in Table 5. In the first line for each age group, the transpiration rate through a prolonged period at room temperatures is given. The latter figures are used as the basis for calculating the comparative rates of transpiration shown in Table 6, which presents the data in more readily interpretable form, so far as the effect on the rate of transpiration of increased temperature and period of exposure are concerned.

Figures 2 and 3 depict the data of Table 5 in graphic form. The lines extending across the sheets for each age-class connect the average transpiration points for each exposure group in order to bring out more clearly the relationship between duration of heat exposure and decline in transpiration rate.

The results obtained in this series are discussed on the basis of the effect of the various elements of exposure upon the transpiration rate.

TRANSPIRATION RATE AND AGE

The amount and rate of transpiration drop off as the seedlings grow older. This is apparently true both when critical and non-critical temperature exposures are involved and holds for all species. It would be reasonable to expect the rate to decrease because of increased dry weight on which the rate is based, but there is a perceptible decrease in actual quantity transpired. This is most quickly seen when the basic transpiration rates (at room temperatures) are compared with average seedling weights in milligrams at the different ages, as given in Table 7.

The ratio of transpiration over dry weight decreases least rapidly and most uniformly in western yellow pine. All evidence indicates that western yellow pine is most consistently uniform in normal transpiration functioning through the first year.

In actual rate of transpiration, Engelmann spruce and lodgepole pine run hand in hand, with the former somewhat ahead of the other at 68 and 122 days. Western yellow pine has a much slower rate than the other species, except at one year, when its ratio exceeds that of Douglas fir. At this age all species are much more alike in their tendencies than at the earlier ages.

TRANSPIRATION RATE AND DURATION OF EXPOSURE

As a general rule, the rate of transpiration decreases with any given temperature as the period of exposure increases for all ages up to one year. The degree in which transpiration is decreased by extending

TABLE 5

TRANSPIRATION RATES AT HIGH AND CRITICAL TEMPERATURES EXPRESSED IN MILLIGRAMS PER GRAM OF DRY SEEDLING WEIGHT

1925

Seedlings 68 days old (except Douglas fir 42 days)

Max. temp.	Period	Transpiration of Y. P.	Transpiration of L. P.	Transpiration of D. F.	Transpiration of E. S.
° F.	mins.	mgs.	mgs.	mgs.	mgs.
69.0	1068	8.6	41.4	26.2	47.6
111.4	60	51.0	109.5	113.2	171.7
120.5	15	74.2	580.0	296.0	401.7
121.8	30	66.2	476.7	298.8	237.5
126.3	60	49.7	137.5	194.4	163.9
130.4	15	60.5	376.7	470.8	591.7
131.7	30	58.0	252.2	188.1	372.2
132.3	60	52.9	160.7	200.5	213.9
140.6	15	86.0	466.7	327.0	264.4
142.2	30	73.4	344.2	211.8	489.6
152.0	15	128.4	213.7	256.1	275.6

Seedlings 122 days old (except Douglas fir 96 days)

Max. temp.	Period	Transpiration of Y. P.	Transpiration of L. P.	Transpiration of D. F.	Transpiration of E. S.
° F.	mins.	mgs.	mgs.	mgs.	mgs.
74.0	970	4.0	18.1	6.3	24.3
122.8	60	38.2	96.0	72.6	181.3
131.3	15	55.0	219.0	84.0	183.3
131.5	30	52.3	147.9	75.5	156.9
132.5	60	37.0	97.0	79.8	102.5
145.0	15	49.2	204.2	130.6	173.2
142.5	30	29.7	191.2	112.4	96.4
141.3	60	37.2	69.9	67.4[1]	63.9
151.3	15	66.1	195.2	114.6	226.4
152.5	30	39.0	136.1	76.9	214.7
166.8	30	40.6	150.0	114.6	132.8[2]
178.0	15	70.7	167.9	160.9	312.0

Seedlings about 1 year old

Max. temp.	Period	Transpiration of Y. P.	Transpiration of L. P.	Transpiration of D. F.	Transpiration of E. S.
° F.	mins.	mgs.	mgs.	mgs.	mgs.
77.0	960	2.76	3.75	1.71	3.26
124.1	60	16.5	28.4[1]	32.6	26.5
134.0	30	29.8	40.8	46.2	87.2
131.0	60	18.3	37.3	18.4	26.0
141.0	20	62.8	66.2	34.3	
141.5	30	23.8	21.2	33.5	39.9[1]
142.0	60	28.8	43.1[1]	24.7	36.2
152.6	20	39.9	51.5	33.8	
152.6	30	23.4	34.0	34.3	33.6
162.2	20	30.1	77.8	39.0	41.3

[1]One seedling only in place of the usual two and occasional three.

[2]Period extended to 38 minutes.

the period is about the same for all ages. The rate of decrease in transpiration is less rapid than the rate of increase in time. All things considered, western yellow pine seedlings with the slowest rate for short exposures are least affected by extending the period of exposure. Douglas fir ranks next while the smaller seedling species, lodgepole pine and Engelmann spruce, show a rather abrupt drop from the 30-minute to the 60-minute period in the 68-day-old class. It is deduced from the data that seedling size determines the capacity of each species to prolong its transpiration.

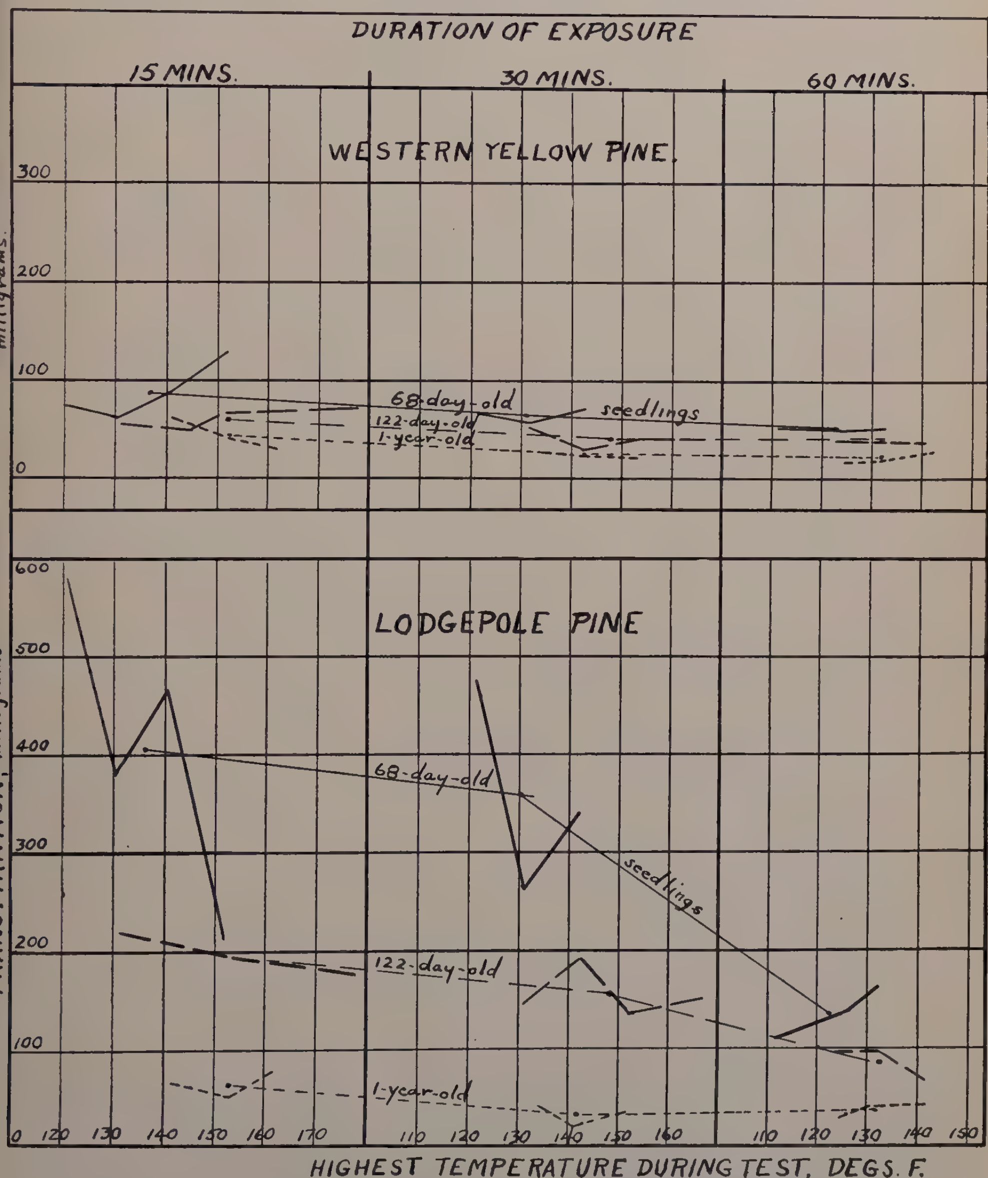

Fig. 2.—Transpiration rates at high temperatures, 1925 tests, for different ages of seedlings and lengths of exposure in milligrams per minute per gram of dry seedling weight.

TRANSPIRATION RATE AND TEMPERATURE

In considering the entire subject of heat tolerance in its relation to transpiration, the temperature factor is naturally of primary importance. Since in the Central Rocky Mountains, the combination of environmental conditions favorable to the germination of coniferous seeds is not likely to occur before early summer, the seedlings may be subjected to highest maximum temperature exposures when extremely young. From this it is axiomatic that the problem is focused upon the

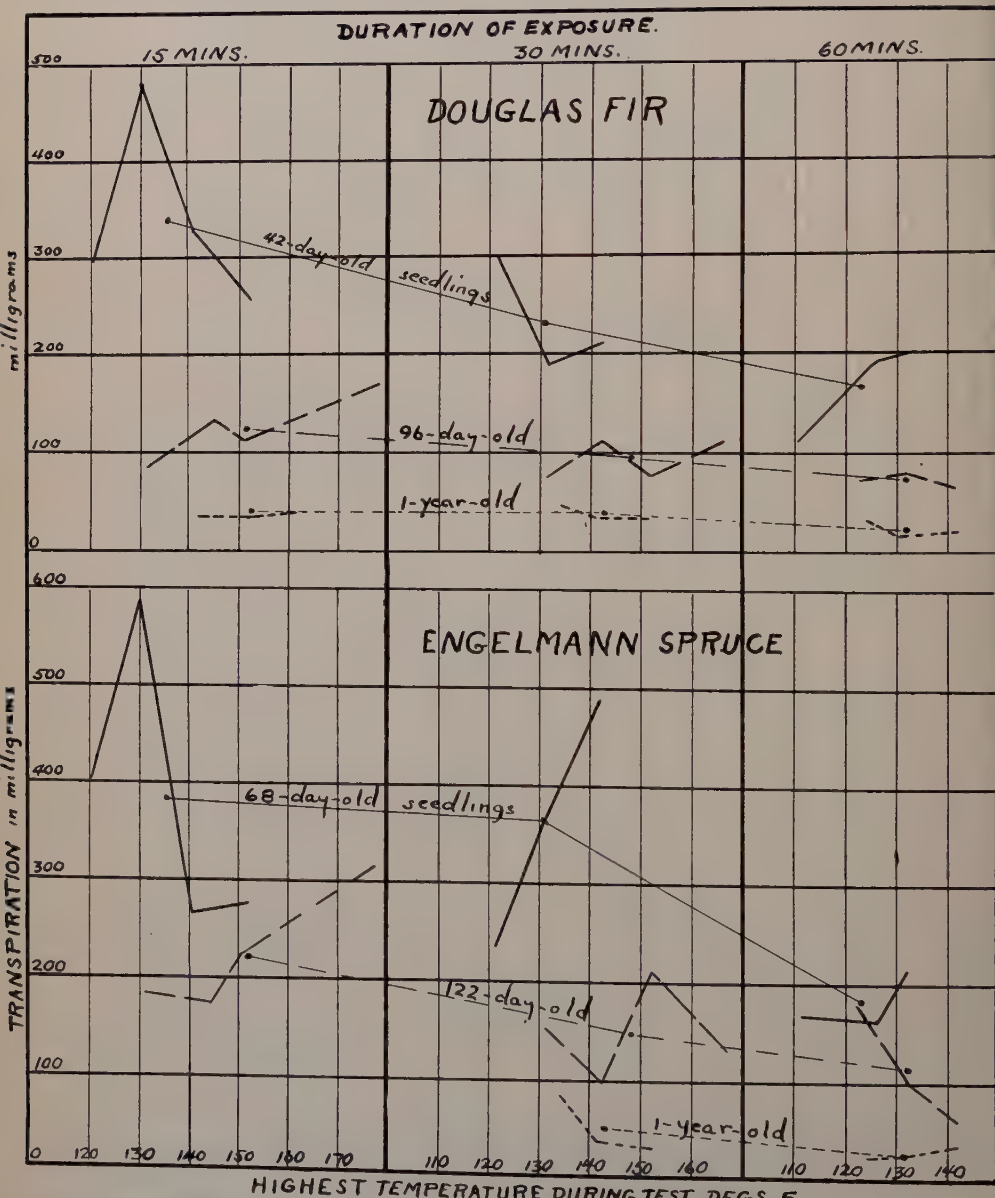

Fig. 3.—Transpiration rates at high temperatures, 1925 tests, for different ages of seedlings and lengths of exposure in milligrams per minute per gram of dry seedling weight.

youngest seedlings and upon their ability to withstand excessive heating.

Referring to Table 5 and Figures 2 and 3, it is seen that western yellow pine at the youngest age is the only species exhibiting a tendency to generally increase its transpiration rate with rising temperature in the short period, and it is quite probable that its capacity to respond promptly is in large part the answer to the problem of seedling heat tolerance. A similar increase is not apparent as the period of exposure is increased, but the rate remains approximately constant. On the other hand, lodgepole pine, Douglas fir and spruce show a pronounced tendency with the longer periods of exposure to increase their transpiration rate with increasing temperature. This tendency is especially conspicuous at 60 minutes, and less so at 30 minutes, except for spruce, which is apparently more sensitive to stimulation than lodgepole pine and Douglas fir.

Douglas fir, Engelmann spruce and western yellow pine seedlings 122 days old are similar in their reaction to the younger seedlings. At the age of one year, western yellow pine shows a progressive decrease in rate of transpiration with rising temperature for the 15-minute and 30-minute periods, but at this age, in all probability, its ability to react is no longer of major significance.

The general reaction of lodgepole pine, especially at 68 and 122 days, suggests that it is relatively incapable of protecting itself against excessive heating by increased transpiration. It has been noted that the new (second-year) growth of lodgepole is peculiarly susceptible to heat injury, which lends support to this opinion. Evidently if this species possesses any superiority over the others, it is in its general profuse use of water and

TABLE 6

TRANSPIRATION RATES OF CONIFEROUS SEEDLINGS AT HIGH AND CRITICAL TEMPERATURES EXPRESSED AS MULTIPLES OF THE BASIC RATE AT ROOM TEMPERATURES

Max. temperature of group[1]	Western yellow pine 15[2]	30	60	Lodgepole pine 15[2]	30	60	Douglas fir 15[2]	30	60	Engelmann spruce 15[2]	30	60
Seedlings 68 days old (Douglas fir 42)												
Transpiration Rate												
111	----	----	6.0	----	----	2.6	----	----	4.3	----	----	3.6
120	8.7	7.7	5.8	14.0	11.5	3.3	11.3	11.4	7.4	8.4	5.0	3.4
130	7.1	6.8	6.2	9.1	6.1	3.9	18.0	7.2	7.7	12.4	7.8	4.5
140	10.0	8.6	----	11.3	8.3	----	12.5	8.1	----	5.6	10.3	----
150	15.0	----	----	5.2	----	----	9.8	----	----	5.8	----	----
Seedlings 122 days old (Douglas fir 96)												
120	----	----	9.6	----	----	5.3	----	----	11.5	----	----	7.5
130	13.8	13.1	9.2	12.1	8.2	5.4	13.3	12.0	12.7	7.5	6.5	4.2
140	12.3	7.4	9.3	11.3	10.6	3.9	20.7	17.8	10.7	7.1	4.0	2.4
150	16.5	9.8	----	10.8	7.5	----	18.2	12.2	----	9.3	8.8	----
170	17.7	10.2	----	9.3	8.3	----	25.5	18.5	----	12.8	5.5	----
Seedlings one year old												
120	----	----	6.0	----	----	7.6	----	----	19.1	----	----	8.1
130	----	10.8	6.6	----	10.9	9.9	----	27.0	10.8	----	26.8	8.0
140	22.8	8.6	10.6	17.6	5.7	11.5	20.1	19.6	14.5	----	12.2	11.1
150	14.5	8.5	----	13.7	9.1	----	19.8	20.1	----	----	10.3	----
160	10.9	----	----	21.0	----	----	22.8	----	----	12.7	----	----

Duration of exposure, minutes.

[1]For exact maximum of individual tests consult Table 5.
[2]Twenty minutes for one year seedlings.

not in any specific response of the transpiratory mechanism to severe conditions. It is possible that its heat requirements have been misjudged. The experiment indicates that lodgepole pine is adapted to conditions of moderate heat where it can withstand exposure perhaps more successfully than any of the other species because of its apparent tendency to transpire more freely, but that it can not, apparently, successfully resist the critical temperatures to which western yellow pine is exposed. The reactions obtained with lodgepole appear to express its physiological adaptation to the conditions prevailing on the sites which it normally occupies. It is a high altitude species, of erratic germination tendencies, and slow to push its roots into the soil. This implies that it needs and is accustomed to considerable surface moisture. It regenerates under open conditions especially after fires, and thus is subject to prolonged and high, but apparently not critically intense, insolation to which it adapts itself by its capacity to transpire readily. The fact that its reactions, growth and rooting habits are similar to those of spruce, would tend to indicate that the latter species, were it not for the fact that its seeding and germinating habits are distinctly different from those of lodgepole and not well adapted to regeneration after fire, would perform quite similarly under the same conditions.

Conclusions

The results obtained in the transpiration tests are not offered with the idea that they represent absolute standards of response to any and all degrees of heat exposure. Because of certain limitations of experimental control, their significance depends not so much upon their statistical value, as upon their value in providing a qualitative basis of comparison between species.

Under conditions of normal temperature exposure, lodgepole and spruce seedlings, during the first year of existence, transpire more freely than western yellow pine and Douglas fir on the basis of dry weight. Spruce and Douglas fir proved more efficient than the pines in their use of water only when in an extremely quiescent condition induced by low temperature and high humidity, which might be suggested as "normal" for these two shade-tolerant species under natural conditions of seed-bed exposure. Western yellow pine seedlings are most consistent in transpirative functioning during the first year. Because of rapid growth and early development of protective stem tissue, they are better protected than are the other species against excessive heat, but what is most important is that this species, in very early age, is apparently more quickly stimulated to increase its transpiration under conditions of extreme ex-

Table 7

EFFECT OF AGE ON TRANSPIRATION AT ROOM TEMPERATURES

Age[1]	Western yellow pine		Lodgepole pine		Douglas fir		Engelmann spruce	
	Av. seedlings weight (mgs.)	Rate[2] of transpiration	Av. seedlings weight (mgs.)	Rate of transpiration	Av. seedlings weight (mgs.)	Rate of transpiration	Av. seedlings weight (mgs.)	Rate of transpiration
68 days[3]	38	8.56	5.5	41.43	8	26.17	4	47.60
122 days[3]	61	4.00	9	18.10	24	6.30	7	24.30
1 year	80	2.76	29	3.75	34	1.71	14	3.26

[1]First test at 69° F., second at 74°, and 1-year test at 77° F. Each for about 16 hours.

[2]Milligrams per gram of dry weight.

[3]Douglas fir approximately 26 days younger.

posure than are the seedlings of any of the other species. Since it seems to endure prolonged exposures more successfully than the others, size and bulk appear to be the determining factors when such conditions exist. As far as heat resistance is concerned, it is probable that variations in transpiration capacity among the species is of vital significance only during the very early life of seedlings, when they are compelled to increase their rate rapidly to adjust themselves to high and rapidly induced critical temperatures. More generally, resistance is a matter of morphological adaptation since the stem at the ground line is the part most often injured. All things considered, western yellow pine is well adapted to meet the demands made upon it in early life by the xerophytic conditions of its natural habitat. Douglas fir is similar to western yellow pine in early deep rooting habit, but in its case, this character appears to have been fixed not by the physiological necessity of tapping available soil moisture sources sufficient to enable it to meet excessive transpiration demands, but by the need of reaching enough moisture to sustain life under adverse seed-bed conditions, such as are found in the presence of heavy accumulation of rapidly desiccating leaf litter and humus. It has not adjusted itself to meet the requirements of excessive and injurious heat exposures either by morphological or physiological adaptation. In this respect, the evidence herewith presented indicates it must be rated below its contemporary species in the Central Rocky Mountains.

The results here, which indicate wide variations of response between the seedlings of different species as the conditions affecting transpiration are altered, may to some extent explain apparent inconsistencies in other attempts to "rate" the species. Thus the transpiration data presented by Bates (2) for the same group of species represents the normal range of temperatures in sunshine and the behavior of seedlings 3-6 years old. Inferences drawn from such conditions may have no safe application under conditions of extreme exposure, but possibly more nearly represent the behaviors of the several species after they have grown beyond the dangers of their very early existence.

References

1. Baker, Frederick S., 1929. Effect of excessively high temperatures on coniferous reproduction. Journal of Forestry, Vol. XXVII, No. 8.
2. Bates, C. G., 1923. The physiological requirements of Rocky Mountain trees. Jour. of Agri. Res. Vol. XXIV, No. 2.
3. Bates, C. G. and Jacob Roeser, Jr., 1924. Relative resistance of tree seedlings to excessive heat. U. S. D. A. Bul. 1263.
4. Hartley, Carl, 1918. Stem lesions caused by excessive heat. Jour. of Agri. Res. Vol. XIV, No. 13.
5. Roeser, J. Jr., 1920. Wilting from excessive heat. An unpublished progress report.

THE CALCIUM CONTENT OF CONNECTICUT FOREST LITTER[1]

By WALTER URBAN GARSTKA

The Pennsylvania State Forest School

The calcium cycle has a more definite development in forest soil than in agricultural soil. The calcium content of forest soil is constantly increasing from the additions received from forest litter. Total and replaceable calcium determinations were made on forest litter. The author expected that there would be an orderly progression of total calcium contents with reference to the successional progression of the forest types toward the climax, but the data show only a trend in this direction.

THIS PROBLEM was undertaken to learn how the total and replaceable calcium in the litter is distributed among the Connecticut forest types which are representative stages in the successional series progressing towards the climatic climax of the region.

Soil technologists have long appreciated the many influences which calcium has upon the characteristics of agricultural soils and upon plant life associated with them. Agronomists have amassed an immense literature concerning the various roles of calcium in crop production. Because of differences in technique, length of rotation, and value of agricultural crops as compared with forest crops, but little of the work of agronomists concerning calcium has any bearing upon the problems of forest production.

One of the basic differences between an agricultural soil and a forest soil is the more definite development of the calcium cycle in the forest soil than in the agricultural soil. Calcium is one of the most readily leached elements in cultivated soils. The presence of CO_2 in the air and in soil water renders calcium carbonate soluble in water through the formation of the bi-carbonate. It is commonly observed that most soils which have formed from limestone bedrock are slightly, often distinctly, acid due to this leaching.

Calcium is necessary for the normal root and leaf development of green plants. It is necessary for the formation of cell walls, which contain calcium pectate. It is also thought by Raber (12) to favor the digestion of starch and its translocation from one part of the plant to another.

The calcium content in the upper layers of an agricultural soil is continually decreasing, while that of the upper layers of a forest soil is increasing, being replenished by the calcium in the leaf litter. Henry (7) found that just before leaf fall the potash and phosphoric acid content of forest leaves decreases, while the amount of calcium and silica increases, so that soon after leaf fall the leaves can be considered as a calcareous fertilizer, their ash containing from 30 to 50 per cent of lime. Table 1, from Henry (7), in which the figures have been converted to percentages of calcium, bears out this statement.

Ebermayer (3) gives analyses of a few species. His figures, converted to percentages of calcium, appear in Table 2.

Ebermayer (13) found that the annual leaf fall of beech was 2,972 pounds per

[1]The author wishes to acknowledge his indebtedness to Professor M. F. Morgan, of the Connecticut Agricultural Experiment Station and the Yale School of Forestry, and to Dr. J. W. Toumey, of the Yale School of Forestry, under whose joint direction this problem was carried out, for their suggestions and aid in the completion of the problem. The author wishes to thank Dr. H. A. Lunt, of the Connecticut Agricultural Experiment Station, for active aid in the field work and for valuable suggestions concerning laboratory procedure; and to Dr. Raphael Zon, Director of the Lake States Forest Experiment Station, for bibliographical asistance.

acre and that of pine was 2,842 pounds per acre. His method of collecting the leaves, according to Ney (13), was not very exact.

The data in Table 3 on jack, Norway, and white pines in the Lake States is taken from Alway and Zon (15). The percentages have been converted to percentages of calcium.

and bedrock would cause a podsol formation. Through the abundant leaf fall, the lime content especially, is increased in the upper layer - - - - and flocculates the humus matter, changing it to a very slightly soluble type. In this case the humus matter does not favour washing out and there is no layer of light colored earth." He continues, "The lime content of the beechleaf litter and the spruce needle litter is considerable in comparison with that of the pine needle litter. If, in addition to this, it be borne in mind that the very resinous spruce and pine needles take longer to rot than the leaf litter, it will become clear that leaf litter favours the formation of the more coaguated humus."

Table 1

CONTENT OF CALCIUM IN LEAVES OF DIFFERENT AGES
Based on Ash Weight

Oak		Beech		Spruce		Larch	
August	Dead leaves	May	Dead leaves	June	Dead leaves	October	Dead leaves
18.52	32.53	13.30	21.75	7.38	22.53	10.40	15.61

It is evident that a large amount of calcium in organic form as leaves is dropped annually to the surface layer of a forest soil. Meanwhile, the trees have been absorbing inorganic calcium from the soil solution through the roots and supplying it to the leaves. Since the organic calcium is not readily leached, as shown by Henry (7) an accumulation of calcium in the upper layer of a forest soil takes place.

Under special conditions the accumulation of calcium may exert its influence in a striking manner. Aarnio (1) has noted the presence of brown earth in Finland, a country in which the predominating soils are of the podsol formation. He states that, "The formation of brown earths is in these cases dependent on the vegetation, for the influence of climate

Table 2

CALCIUM CONTENT OF LEAF LITTER, AFTER EBERMAYER

Species of litter	Percentage of calcium based on oven-dry litter weight
Beech	1.75 per cent
White fir	1.44 per cent
Larch	.62 per cent
Ash	1.21 per cent
Pine	.42 per cent

This variation in the rates of decomposition of leaves of such widely separated genera as beech and spruce or pine would normally be expected, but Krauss, as cited by Melin (11), investigating the lime and silica content of beech leaves (*Fagus sylvatica* L.), from different localities and sites in Germany, found that there was a very wide variation in the content of these substances. He proved that the quantities of lime and silica, on the whole, were in inverse ratio to each other. He thus concluded that when the supply of lime in the soil is small, the silica content of the beech leaves will be augmented, which appears to retard their decomposition.

Timmel (14) found that the removal of the forest litter reduces the yield of timber about one half in the first rotation, in lower Austria, and still more in follow-

ing crops due to the deterioration of the soil.

Classification of Forest Types

According to Lutz (10) there are three upland forest associations in southern New England, as follows:

1. The red cedar—gray birch association.
2. The hardwood association.
3. The hemlock-hardwoods association.

The red cedar—gray birch association is the first in the successional order, while the hemlock-hardwoods association is the climatic climax of this region. The hardwood association occupies by far the largest area in Connecticut and embraces a very wide range of forest types.

The Society of American Foresters has made a forest region and type classification of New England (5) and (6). The publications were studied, with the conclusion that the classification was not suitable for serving as a basis for this project. Therefore, a list of forest types consisting of the successional stages which have a wide distribution in Connecticut, or which represent very definite stages in succession, was compiled. The types are listed in Table 4 in ascending order towards the climax.

Pitch pine is in general a physiographic climax in this region. Since the successional series may start from either gray birch or white pine, the types have been listed on one line in the above list. The scarlet oak-mixed oaks type may become a climax on ridge top sites. The bottomland hardwoods type may become a physiographic climax on site containing stagnant soil water, although ordinarily it is the last stage before the climatic climax of hemlock-hardwoods.

Collection of Samples

Three samples were collected from widely separated locations for each of the types, with the exception of pitch pine and hemlock-hardwoods, for each of which four samples were collected.

The material chosen consisted of very slightly decomposed and quite definitely unhumified litter. Special attention is called to the fact that freshly fallen leaves were not collected. The litter on which these studies were made had been influenced by a slight decomposition and had been subjected to leaching. The various biological processes, active in the decomposition of forest debris, had begun to act on it. The material analyzed was, therefore, not simply representative of the tree species making up that type, but had been affected by the climatic and biological factors affecting the forest as a whole.

Table 3

CALCIUM CONTENT OF JACK, NORWAY, AND WHITE PINES

After Alway and Zon

Sample	Calcium content per cent	Weight of oven-dry litter per acre in pounds	Weight of calcium in litter per acre in pounds
Plot I, Cloquet. Jack and Norway pines	.56	33,541	188
Plot II, Cloquet. Pure Norway pine	.53	33,987	181
Plot III, Cloquet. Pure jack pine	.59	16,553	97
Plot IV. Cass Lake. Mixed Norway and white pines	.67	23,958	160
Plot V, Cass Lake. Pure jack pine	.70	32,670	229

The map, Figure 1, shows the geographical distribution of the samples in the state of Connecticut.

Procedure

The procedure consisted of four parts:
1. Preliminary treatment of samples.
2. Moisture determinations.
3. Total calcium determinations.
4. Replaceable calcium determinations.

PRELIMINARY TREATMENT

The samples were collected from sites on which there was a sufficient area of uniform forest to prevent the influx of appreciable quantities of litter from adjacent types. Level areas, or those nearly so, were chosen, since litter would tend to accumulate at the lower portion of a slope, and since drainage conditions upon slopes would also be different.

The litter was reduced to uniform size with a Hobart Food Chopper, so that no particles were retained by a 20-mesh screen. It was then placed in moisture-proof cans, from which portions were removed at intervals as required for analyses. The moisture content of the litter remained constant in these cans.

MOISTURE DETERMINATIONS

Two sixteen-gram portions of each sample were dried in a constant-temperature electric oven at 105° C. until two weighings on a torsion balance, taken at intervals of twenty-four hours, showed no continued decrease in weight. The moisture-free weight of litter, to serve as a basis for the calcium determination, was then computed.

Litter which had been drying in cotton bags for four months was dried to constant weight in four days and showed a moisture content of 7.5 per cent. Some litter, which had been collected during a light rain, after appearing outwardly as air-dry as the above-mentioned litter, took sixteen days to reach constant weight and showed a moisture content of 25 per cent. This shows the difficulty of removing the last traces of moisture from the litter studied even at 105° C. Moisture contents are expressed on an air-dry basis.

CALCIUM DETERMINATIONS

All determinations were made in duplicate and were repeated if they did not show concordant results. Total calcium was obtained by the ignition of two-gram portions of air-dry litter in a muffle furnace at a dull redness for three and one half hours. Replaceable calcium was leached from 16-gram portions of air-dry litter with N/20 HCl, using 450 cc per portion.

Table 4

FOREST TYPES BASED ON SUCCESSION IN ASCENDING ORDER

Gray birch (Old field)	White pine (Old field) (Immature)	White pine (Old field) (Mature)
Seedling hardwoods following gray birch		
	Scarlet oak-mixed oaks (Immature)	Scarlet oak-mixed oaks (Mature)
	Mixed oaks	Oak-hickory hardwoods
	Bottomland hardwoods (Immature)	Bottomland hardwoods (Mature)
	Hemlock-hardwoods (Climatic climax)	
Pitch pine (Aphysiographic climax)		

Both total and replaceable calcium was determined by precipitation as calcium oxalate and titration with N/10 or N/5 potassium permanganate solution.

The chemical procedure is based on the following references: (2) pages 39-42; (4) pages 65-66; and (9) page 144.

Results

The samples have been grouped by forest types in Table 5 to show the magnitude of difference between the samples within a given forest type. The percentages are the averages of duplicates for each sample. Table 6 is a table of averages for each forest type, compiled from Table 5.

One sample of pure beech litter was collected. The data resulting from its analyses are found in Table 5 but not in Table 6. The pure beech type is not of wide distribution in Connecticut. The sample was used for adjusting technique because of its uniformity. Figure 2 presents graphically part of the data found in Table 6.

Discussion of Results

A study of Table 5 shows that, on the whole, there is a remarkable degree of uniformity in the total and replaceable calcium contents of samples widely separated geographically and from different soil types, but of the same forest type.

Sample No. 4 has been classed with the mature bottomland hardwoods type, although it was found on a very well-drained site. It was collected under one of the best stands of hardwoods seen in the search for samples. The species consisted of basswood, beech, hard maple, and red oak. The analytical results show that it

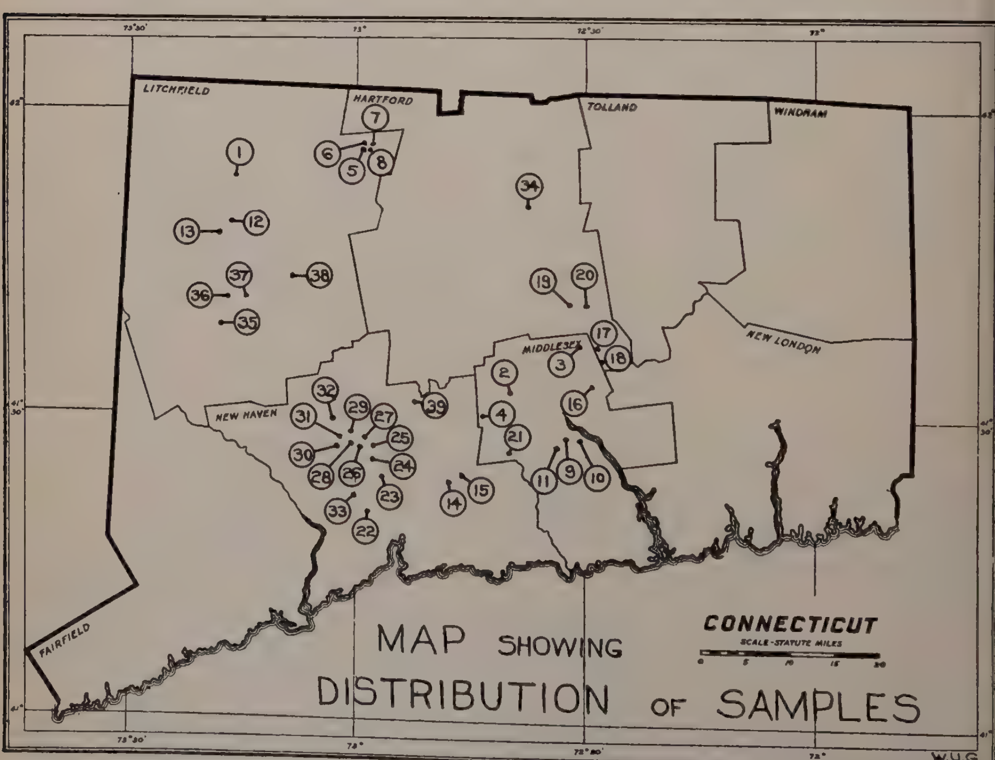

Fig. 1.—Map showing distribution of samples.

TABLE 5

TABLE OF DETAILED AVERAGES FOR EACH FOREST TYPE

Sample number	Forest type	Moisture per cent	Per cent of ash on oven-dry weight	Per cent total calcium in ash weight	Per cent total calcium in litter weight	Per cent replaceable calcium in litter weight	Ratio—per cent of replaceable calcium to per cent of total calcium both on litter weight
14	Pitch pine	17.35	1.57	18.07	.27	.09	.350
15		16.61	1.97	19.95	.39	.12	.318
19		18.18	2.15	18.18	.39	.14	.348
20		9.20	3.09	10.87	.34	.13	.397
	Average		2.19	16.77	.35	.12	.353
21	Gray birch (Old field)	9.94	6.81	18.84	1.28	.57	.454
26		24.84	6.83	11.49	.78	.54	.698
29		16.84	9.08	10.00	.91	.53	.586
	Average		7.57	13.44	.99	.55	.576
5	White pine (Old field) (Immature)	7.32	8.32	5.96	.50	.20	.402
11		8.00	3.19	30.78	.98	.35	.362
27		15.55	4.96	14.56	.72	.40	.552
	Average		5.49	17.10	.73	.32	.439
23	White pine (Old field) (Mature)	10.33	8.49	4.86	.44	.22	.511
34		9.61	9.11	5.10	.46	.23	.504
38		16.81	3.71	14.08	.52	.27	.511
	Average		7.10	8.01	.45	.24	.508
16	Seedling hardwoods following gray birch	23.21	6.75	16.10	1.09	.60	.553
17		23.24	9.88	17.47	1.73	.71	.411
22		9.38	6.59	26.42	1.74	.64	.371
	Average		7.77	19.99	1.52	.65	.445
10	Scarlet oak-mixed oaks (Immature)	9.15	4.28	24.68	1.06	.27	.225
25		24.35	6.76	14.56	.98	.47	.475
31		9.45	5.77	12.66	.80	.33	.412
	Average		5.60	17.30	.95	.36	.381
3	Scarlet oak-mixed oaks (Mature)	7.52	4.82	15.04	.72	.38	.528
35		8.57	7.37	17.82	1.31	.48	.366
39		19.06	8.94	14.99	1.34	.52	.392
	Average		7.04	15.95	1.12	.46	.429
6	Mixed oaks	7.04	4.08	27.80	1.13	.48	.424
28		18.66	7.23	18.10	1.31	.57	.435
36		8.32	5.32	17.62	.94	.42	.450
	Average		5.54	21.17	1.13	.49	.436
30	Oak-hickory hardwoods	17.62	9.24	24.11	2.23	.85	.381
32		10.93	7.75	19.35	1.49	.55	.369
2		7.07	9.57	9.03	1.50	.54	.354
	Average		8.85	17.50	1.74	.65	.368
12	Bottomland hardwoods (Immature)	10.32	7.69	24.47	1.88	.80	.427
18		22.12	7.53	20.56	1.55	.73	.468
24		10.73	9.87	11.29	1.11	.74	.663
	Average		8.36	18.77	1.51	.76	.519
4	Bottomland hardwoods (Mature)	6.63	16.66	9.03	1.50	.61	.404
33		10.72	9.82	12.03	1.18	.51	.436
37		16.54	9.36	18.12	1.69	.83	.488
	Average		11.98	13.06	1.46	.65	.443
8	Hemlock-hardwoods	7.73	4.52	23.35	1.06	.33	.312
1		7.08	9.87	14.82	1.46	.60	.412
9		9.72	4.41	21.45	.95	.28	.296
13		9.21	4.83	20.88	1.01	.44	.440
	Average		5.91	20.12	1.12	.41	.365
7	Pure beech	9.16	5.01	28.87	1.45	.55	.382

did not stray far from the mean for the mature bottomland hardwoods type.

Sample No. 3, of the mature scarlet oak-mixed oaks type which at times becomes a physiographic climax on ridgetop sites, was collected at the top of Meshomasic Mountain. The forest consisted of practically pure scarlet oak, stunted, and growing in a semi-parklike stand. The calcium content of this sample is considerably below that of its companion samples, but it is still higher than the average for the mature old field white pine type.

The mature old field white pine type is lower in total calcium than the immature

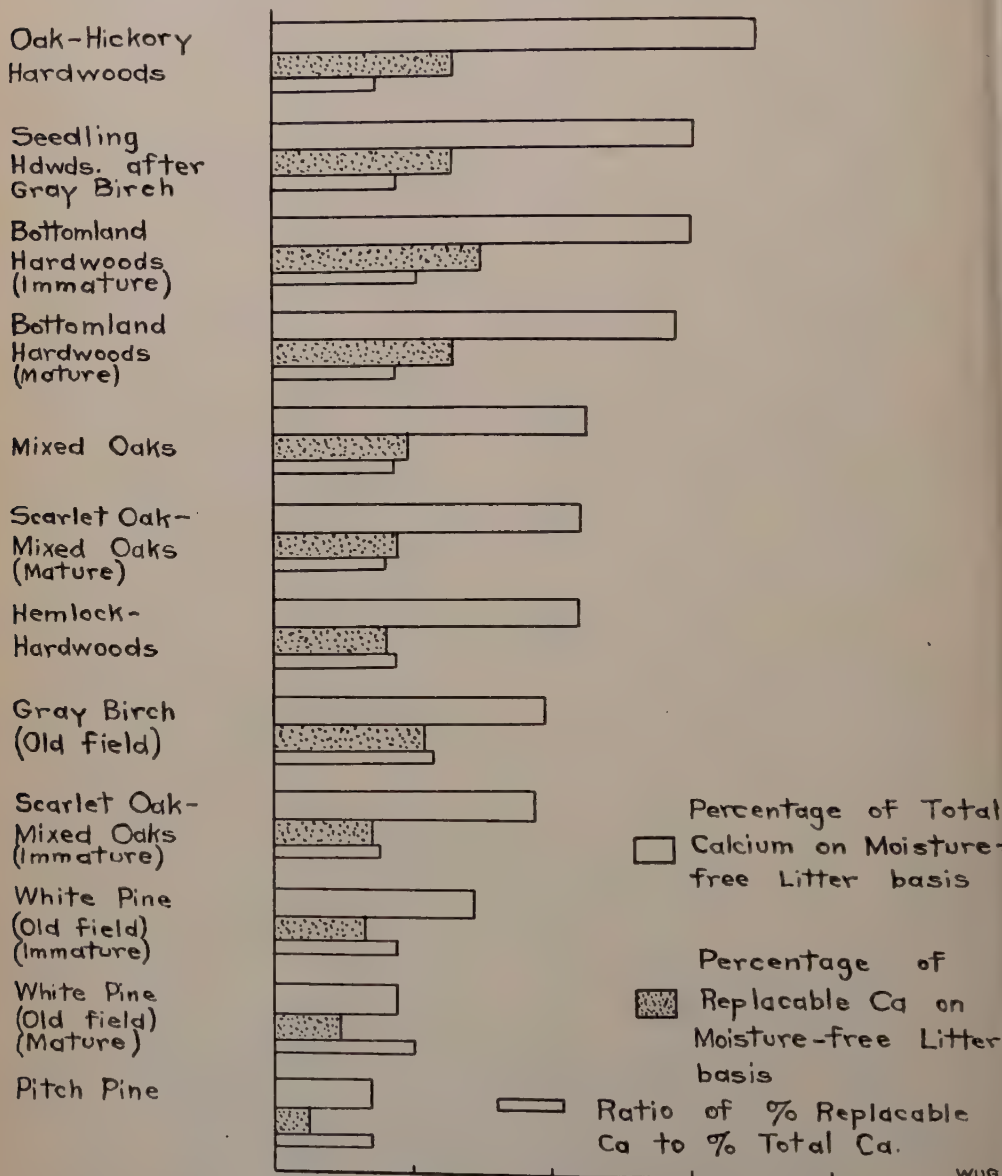

Fig. 2.—Forest types in the order of their total calcium content.

type, suggesting that a deterioration of the soil fertility may have taken place under its occupation by white pine. Meanwhile, the total calcium content of mature and immature bottomland hardwoods types is practically the same.

The pitch pine samples show a very low ash content, while that of the mature bottomland hardwoods is highest.

Figure 2 lists the forest types in the order of their total calcium content. Three groupings of types develop. With the exception of two forest types, this grouping would be the same if the listing was done in the order of the replaceable calcium content. The ratio of replaceable to total calcium remains practically constant.

A replaceable calcium determination, according to this study of forest litter, does not seem to be as indicative of soil fertility as has been found with mineral agricultural soils. In the following quotation from Hesselman (8) CaO_{ass} means assimilable (replaceable) calcium, "On account of the relation between CaO_{ass} and pH on one hand, and on account of the relation between nitrogen transformation and pH - - - - on the other hand, a relation between CaO_{ass} and nitrogen transformation was expected. However, - - - - it is weak with the exception of the total nitrogen transformation after inoculation, which shows an optimum in the group with lime content of between 2.0 and 2.5 per cent."

This apparent change in the significance of the replaceable calcium of mineral soil and forest litter may be caused by a difference in the nature of the so-called "replaceable" calcium in mineral soil and in litter. Calcium pectate is one of the common constituents of plant cell walls. Henry (7) states that at the time of leaf fall, "the leaves were reduced essentially to a series of cellular membranes heavily incrusted with lime and silica." The cutting of the leaf into small particles for analysis served to greatly increase the area of leaf tissue exposed to the action of the

Table 6

TABLE OF RESULTS GIVING GRAND AVERAGES FOR ALL ANALYSES

Forest type	Percentage of ash on oven-dry litter weight	Per cent total calcium in ash weight	Per cent total calcium in litter weight	Per cent replaceable calcium in litter weight	Ratio—per cent of replaceable calcium to per cent of total calcium both on litter weight
Pitch pine	2.19	16.77	.35	.12	.353
Gray birch (Old field)	7.57	13.44	.99	.55	.576
White pine (Old field) (Immature)	5.49	17.10	.73	.32	.439
White pine (Old field) (Mature)	7.10	8.01	.45	.24	.508
Seedling hardwoods following gray birch	7.77	19.99	1.52	.65	.445
Scarlet oak-mixed oaks (Immature)	5.60	17.30	.95	.36	.381
Scarlet oak-mixed oaks (Mature)	7.04	15.95	1.12	.46	.429
Mixed oaks	5.54	21.17	1.13	.49	.436
Oak-hickory hardwoods	8.85	17.50	1.74	.65	.368
Bottomland hardwoods (Immature)	8.36	18.77	1.51	.76	.519
Bottomland hardwoods (Mature)	11.98	13.06	1.46	.65	.443
Hemlock-hardwoods	5.91	20.12	1.12	.41	.365

N/20 HCl used for leaching the replaceable calcium. Under the conditions of the chemical procedure the hydrochloric acid was able to extract a certain amount of the calcium found in the cellular membrane incrustations. Since the time of leaching and the area of exposed surface were practically equal for most of the determinations, the amount of calcium extracted as "replaceable" varied with the density of the incrustations, in other words, with the total calcium. This explanation is offered for the marked uniformity of the ratio of replaceable and total calcium throughout the range of the forest types studied. In view of the relationship of total and replaceable calcium in forest litter, it seems unnecessary to determine the replaceable calcium content of forest litter.

A forest at its climatic climax is considered to be at its optimum. Soil conditions are thought to be at their best development for the region. It was expected that there would be an orderly progression of total calcium contents with reference to the successional progression of the forest types towards the climax, but the data show only a trend in this direction. Evidently other factors, which cause a decrease in the percentage of total calcium enter. A change in the species, such as the introduction of the conifer, hemlock, would tend to lower the percentage of calcium in the litter.

This study has not been based upon a sufficiently large number of samples within any one forest type to justify the statement of any definite conclusions concerning the subject of calcium distribution in the forest litter at various stages in forest succession. However, it indicates the existence of a correlation between Connecticut forest associations in their trend towards the climax and the calcium content of their litter.

Summary

Thirty-eight samples of forest litter, representing twelve forest types chosen as representatives of the successional progression towards the climatic climax of Connecticut, were analyzed in duplicate for total and replaceable calcium content.

Some of the litter exhibited a very slow rate of drying, taking sixteen days to dry to constant weight at 105° C.

It was found that the replaceable calcium content of litter varied quite uniformly with the total calcium content, the ratio of replaceable to total calcium being 0.439, based on an average of ninety analyses.

The total calcium content appears to give equally as significant data as the replaceable calcium content of the forest litter studied.

The total calcium content showed a general increase with the advance of the forest types towards the climax (hemlock-hardwoods) up to the oak-hickory-hardwoods type, after which it showed a slight decrease.

The study indicates the existence of a correlation between Connecticut forest associations in their trend towards the climax and the calcium content of their litter.

References

1. Aarnio, B. 1925. Brown earth in Finland. International Review of the Science and Practice of Agriculture, Rome, Italy. New Series, Vol. 3:402-408.
2. Association of Official Agricultural Chemists. 1925. Official and tentative methods of analysis, Second Edition. Washington, D. C.
3. Ebermayer, E. 1876. Die lehre der waldstreu. Von Julius Springer, Berlin. Page 108.
4. Emerson, P. 1925. Soil characteristics. First Edition. McGraw-Hill Book Co., Inc., New York, N. Y.
5. Hawley, R. C., Terry, E. I., and Woodward, K. W. 1922. Forest region

and type classification for New England Jour. For. 20:122-129.

6. ————. 1922. Revision of a report on a forest region and type classification for New England. 1922. Jour. For. 20:795-798.

7. Henry, E. 1908. Les sols forestiers (Translated from the French by L. VanRancke).

8. Hesselman, H. 1925. Studies of the humus layers of coniferous forests, their peculiarities, and their dependence upon silviculture. Meddelanden fran Statens Skogsforsokanstalt Hafte 22, Nr. 5, pages 169-552 (Translation of the German resumé by P. R. Gast).

9. Lunt, H. A. 1929. The vertical distribution of soil bases and acidity in some Illinois soils. Soil Sci. 28:137-176.

10. Lutz, H. J. 1928. Trends and silvicultural significance of upland forest successions in southern New England. Yale Forest School Bulletin No. 22.

11. Melin, E. 1930. Biological decomposition of some types of litter from North American forests. Ecology 11: 72-101.

12. Raber, O. 1929. Principles of plant physiology. The Macmillan Book Co., New York, N. Y.

13. Busgen, M., and Munch, E. (Thomson). 1929. The structure and life of forest trees. John Wiley and Sons, Inc., New York, N. Y. Page 199.

14. Timmel, R. 1928. Torf oder waldstreu (Peat or forest litter) Wiener Allg. Forstu. Jagdztg. 46(41)241 (Original not seen—Biological Abstracts No. 1962).

15. Alway, F. J., and Zon, R. 1930. Quantity and nutrient content of pine leaf litter. Jour. For. 28. Page 723.

"Thirty-four years ago, I left England to explore the natural history of the United States. In the ship *Halcyon* I arrived at the shores of the New World; and after a boisterous and dangerous passage, our dismasted vessel entered the Capes of the Delaware in the month of April. The beautiful robing of forest scenery, now bursting into vernal life, was exchanged for the monotony of the dreary ocean, and the sad sickness of the sea. As we sailed up the Delaware my eyes were rivetted on the landscape with intense admiration. All was new!—and life, like that season, was then full of hope and enthusiasm. The forests, apparently unbroken, in their primeval solitude and repose, spread themselves on either hand as we passed placidly along. The extending vista of dark pines gave an air of deep sadness to the wilderness."

The North American Sylva, Thomas Nuttall. 1849.

A COMPARISON OF THE RESULTS OBTAINED WITH FOREST-PULLED AND NURSERY-GROWN PLANTING STOCK IN NORTHERN MINNESOTA

By T. SCHANTZ-HANSEN

Forester in Charge, Cloquet Forest Experiment Station, Cloquet, Minn.

When it can be obtained at reasonable cost the feasibility of using planting stock obtained by lifting wild forest-grown seedlings is determined by its survival and subsequent growth. The author describes the results of a 15-year-old experiment with white and Norway pines, comparing wild with nursery stock. He reports a reasonable degree of success under certain conditions but considers nursery-grown stock superior to the wild.

THE USE OF "forest-pulled" planting stock in reforestation work is not generally approved of by foresters. This lack of approval is based on the assumption that forest-pulled stock is more expensive than nursery-grown stock, when the cost is based on the number of trees surviving. Claridge[1] has shown that forest-pulled southern balsam can be successfully used for forest planting in North Carolina. In this case, however, most of the forest-pulled stock was lined out in nursery rows for one year before being used as planting stock.

As a general rule, nursery-grown stock is preferred to forest-pulled stock because it can be supplied in any age class, species or amount. Forest-pulled stock must be taken as nature supplies it. There are times, however, when nursery stock may not be available and the time of planting cannot be deferred. Under such conditions forest-pulled stock, properly handled, may fill a distinct need. It is therefore desirable to know something about the cost, survival and rate of growth of forest-pulled stock in order to determine its use, both in emergencies and in cases where the stock is available for regular planting work.

When the experimental planting plots were established at the Cloquet Station in 1914-15, there was included a series of eight half-acre plots of forest-pulled stock. The purpose of these plots was to compare the survival and rate of growth of this stock with various classes of nursery-grown stock planted on the same site.

Both white and Norway pine forest-pulled stock was used. The stock was dug from an open cut-over area. As nearly as could be determined, the seedlings were three years old. A cylindrical spade was used, thus cutting the lateral roots and digging the seedling at one operation. This made it possible to get a large part of the roots with a minimum amount of effort. The original stand had been mixed white and Norway pine.

Two men dug the seedlings at the rate of 2,000 per ten-hour day. At the wage rate paid in 1914 this put the cost of digging the stock at \$2.00 per thousand. At this same time, 2-0 stock was produced in the nursery at the Station at 98 cents per thousand, and 2-2 stock at \$3.88 per thousand. The original cost of the stock, even including legitimate overhead costs, was not excessive. Its relative value for forest planting therefore depends largely upon the survival.

In this article the results obtained from only two of the five classes of nursery stock used in the experiment are compared with the results obtained with forest-pulled stock. These two classes, namely

[1]Claridge, F. H. Successful use of woods-lifted seedlings of southern balsam. Jour. For. 28: p. 389-391. 1930.

2-0 and 2-2, were selected because they represent the two extremes in planting stock used in this region. The 2-0 stock has given the poorest results at the Cloquet Station, and the 2-2 the best.

The planting was done on two areas differing greatly in the degree of protection and overhead shade. Area No. 1 was a medium stand of 40-year-old jack pine. There were about 300 trees per acre, averaging 7 inches d.b.h. The ground cover consisted mostly of wintergreen and various herbaceous plants. No brush was present. Area No. 2 was open cut-over land. Here the ground cover consisted of sweet fern, bracken fern and a scattering of willow and poplar. A 6 x 6 spacing was used on all the plots. The planting was done by the slit method.

Fifteen years have passed since the plantings were made. This should afford ample time for the trees to establish themselves and to begin to show differences in growth rate. Table 1 gives the survival and average height of the various classes of stock on Area 1. The figures are based on a count of 100 marked trees of each class of stock scattered throughout the plantings.

Fifteen years after planting the survival of the forest-pulled white pine compares quite favorably with the other two classes of stock. Its survival is 12 per cent below that of the 2-0 stock and 9 per cent below that of the 2-2 stock. Its average height is 9 inches less than that of the 2-0, and 12 inches less than that of 2-2 stock. Because forest-pulled stock does not have as well developed a root system as nursery stock it is reasonable to expect a somewhat lower survival and a slower growth rate.

Fifteen years after planting the survival of Norway pine forest-pulled stock was more than twice that of the 2-0 stock and was within 4 per cent of the survival of the 2-2 stock. The average height of the forest-pulled stock was 12 inches greater than of the 2-0, and 36 inches less than that of the 2-2 stock. Norway pine is only moderately tolerant. The low survival of the 2-0 stock is probably due to the fact that it was too small to survive the competition and overhead shade.

TABLE 1

PERCENTAGE SURVIVAL AND AVERAGE HEIGHT IN INCHES OF NORWAY AND WHITE PINE FOREST-PULLED AND NURSERY STOCK UNDER JACK PINE, ONE, FIVE, TEN AND FIFTEEN YEARS AFTER PLANTING[1]

White Pine

Class of stock	1 year after planting	5 years after planting		10 years after planting		15 years after planting	
	Survival	Survival	Average height	Survival	Average height	Survival	Average height
	per cent	per cent	inches	per cent	inches	per cent	inches
Forest Pulled	82	64	12	57	16	52	27
2–0	79	69	10	65	17	64	36
2–2	94	86	18	72	27	61	39

[1]The percentages are the average of two plots planted in successive years.

Norway Pine

Class of stock	1 year after planting	5 years after planting		10 years after planting		15 years after planting	
	Survival	Survival	Average height	Survival	Average height	Survival	Average height
	per cent	per cent	inches	per cent	inches	per cent	inches
Forest Pulled	88	58	10	49	18	46	24
2–0	76	40	5	25	8	22	12
2–2	98	68	19	51	30	50	60

On this area the forest-pulled stock, while somewhat inferior to the nursery-grown stock, gave reasonably satisfactory results. Fifteen years after planting 600 trees per acre remained.

Table 2 gives the survival and average height of the various classes of planting stock on the cut-over open area.

On the cut-over area the survival and growth of both the white and Norway pine nursery stock is clearly superior to that of the forest-pulled stock. The survival of all types of planting stock on this area is lower than would ordinarily be expected. This is partly due to change in ground cover. After the area was planted grass and brush grew to such an extent as to afford considerable competition. The activities of the snow-shoe rabbit has also reduced survival of the planting. Repeated removal of leaders and laterals by rabbits tends to slow up the rate of growth and eventually to kill the tree. These factors have affected all the plots so that while the survival is low the results of the different classes of stock are still comparable.

A comparison of the results obtained on the two areas shows a much higher survival of the forest-pulled stock under the jack pine stand. This is true even at the end of the five-year-period before rabbits damaged the stock. Five years after planting 64 per cent of the white pine survived under jack pine and 38 per cent on the cut-over area. Five years after planting 58 per cent of the Norway pine survived under the jack pine and 43 per cent on the cut-over area. These results indicate that some shade is beneficial not only for forest-pulled stock, but the other classes as well.

The results indicate that forest-pulled stock of white and Norway pine can be used on some areas with the expectation of a reasonable degree of success. Nursery stock is superior to forest-pulled stock, but not in so large a degree as might be expected. Apparently some overhead shade is as beneficial to the forest-pulled stock as it is to other classes of stock.

TABLE 2

PERCENTAGE SURVIVAL AND AVERAGE HEIGHT IN INCHES OF NORWAY AND WHITE PINE FOREST-PULLED AND NURSERY STOCK ON CUT-OVER OPEN LAND, ONE, FIVE, TEN AND FIFTEEN YEARS AFTER PLANTING[1]

Class of stock	White Pine: 1 year after planting	5 years after planting		10 years after planting		15 years after planting	
	Survival	Survival	Average height	Survival	Average height	Survival	Average height
	per cent	per cent	inches	per cent	inches	per cent	inches
Forest Pulled	64	38	7	34	7	4	12
2–0	62	56	6	54	14	33	15
2–2	96	48	9	44	15	36	15

[1]The percentages are the average of two plots planted in successive years.

Class of stock	Norway Pine: 1 year after planting		5 years after planting		10 years after planting		15 years after planting	
	Survival	Average height	Survival	Average height	Survival	Average height	Survival	Average height
	per cent	inches	per cent	inches	per cent	inches	per cent	inches
Forest Pulled	57	43	43	19	34	22	15	84
2–0	74	68	68	8	49	15	37	15
2–2	94	83	83	17	64	30	34	45

ESTABLISHMENT AND SURVIVAL OF YELLOW POPLAR FOLLOWING A CLEAR CUTTING IN THE SOUTHERN APPALACHIANS

By I. H. SIMS

Appalachian Forest Experiment Station, Asheville, N. C.

In the experiment here described, reproduction was studied on plots under four sets of conditions: clear-cut and burned, uncut and burned, clear cut and not burned, and uncut and not burned. The advantages of cutting and burning proved to be temporary, competition from other vegetation apparently being more potent than favorable seed bed conditions. The fact that the results of this experiment are negative is of especial interest in view of the importance of yellow poplar and the preconception we have had that yellow poplar required only a few easily supplied conditions to assure its plentiful reproduction.

THE FINE stands of yellow poplar (*Liriodendron tulipifera* L.) scattered through the Southern Appalachian region indicate that, given proper conditions, the species regenerates itself plentifully. These conditions have been generally assumed to be: a plentiful supply of seed on mineral soil, moisture, and freedom from overhead shade.

It seems so easy to provide these conditions that the present experiment, which resulted in a practical failure to establish yellow poplar reproduction after various methods of treatment, is of especial interest. It brings out strongly the necessity for considering the factors of environment as of at least equal importance with treatment of the stand in their bearing on the successful establishment of reproduction. In the present case the treatment resulted in substitution of competition of herbaceous growth for that of woody vegetation without reducing the total to a point where the reproduction could be successful.

Purpose and Description of Experiment

The area on which this experiment was performed is in the Bent Creek Valley, Pisgah National Forest, about ten miles from Asheville, North Carolina. The experiment was begun in May, 1925, by E. F. McCarthy then of the Appalachian Forest Experiment Station. The purpose was to provide certain conditions for the establishment of yellow poplar reproduction and to ascertain under which, if any, the establishment would be successful.

The area selected for the experiment is in a narrow, flat bottom along both sides of the creek, about five feet above the water level. The soil, which is slightly acid, is chiefly a brown alluvial silt loam with small scattered areas of silty clay loam. A dense mat of fern roots, 2 to 3 inches thick, overlaid the mineral soil at the time the plots were established. The stand was made up chiefly of red maple, with sourwood, dogwood, black gum, black oak, white oak, and yellow poplar. The three last-named species are the more desirable ones, but they made up a very small proportion of the stand, which averaged 1,600 cubic feet per acre before treatment. Trees removed from the clear cut areas ranged in size up to thirteen inches in diameter breast high.

On April 2, 1925, the flat on one side of the creek was burned over. After the fire, quadrats were established on which the following four conditions obtained: (1) clear cut and burned; (2) uncut, but burned; (3) clear cut, but not burned, and (4) neither cut nor burned. The burned clear-cut and the unburned clear-cut areas were 0.25 and 0.15 acres in extent, respectively. The uncut areas were not formally laid off in plots because

the observations were confined to reproduction of yellow poplar on quadrats. The individual quadrats were 5 feet by 10 feet and were arranged contiguously in parallel rows traversing the different areas. The number of quadrats and their total area under each condition are given in Table 1.

TABLE 1

NUMBER AND AREA OF QUADRATS

Condition	Number of quadrats	Total area of quadrats
		Square feet
Burned, clear cut	40	2000
Burned, uncut	60	3000
Unburned, clear cut	24	1200
Unburned, uncut	26	1300

In the process of clearing the two plots all tree and brush were cut and removed from the areas. The soil was probably disturbed a little during removal of the cut material, but the dense mat of fern roots, from 2 to 3 inches thick, was left practically intact. The completeness of the clearing on the cut areas is shown in Figure 1. One sixteen-inch yellow poplar was left for a seed tree near the edge of the clear cut and burned area. Adequate seed supply for the unburned clear cut area was assured by eight thrifty yellow poplars close to the boundary.

At the time of the first examination, June, 1925, the ground cover consisted chiefly of young ferns and mosses and had a density of 0.1 on the burned clear cut plot and 0.2 on the unburned clear cut area. In July, 1926, however, the ferns covered both areas with dense, lush growth, those of the genus *Osmunda* at

Fig. 1.—The clear cut and burned area immediately after treatment, May, 1925.

taining a height of about 4 feet. Ferns present include lady fern (*Asplenium filix-femina* [L.] Bernn.), cinnamon fern and royal fern (*Osmunda cinnamomea* L. and *Osmunda regalis* L.), and a shield fern (*Aspidium novaboracense* [L.] Sw.). The density of the fern growth has increased yearly until, in 1931, the fronds formed a dense tangle everywhere on the clear-cut areas.

Sprouts from cut stumps had, by July, 1926, become over 5 feet tall. The sprouts, chiefly red maple, continued their rapid growth and in 1931 the dominants had attained a height of over 15 feet. Lateral growth of the sprout clumps has been in keeping with the vigorous height growth. At the last examination the sprout clumps covered about half the cleared areas. Density of the cover on the clear-cut and burned plot in August, 1931, is shown in Figures 2 and 3.

Experimental Data

Yellow poplar seedlings on the quadrats were counted in June, 1925, July, 1926, May, 1927, July, 1929, and October, 1931. A summary of these observations is presented in Table 2.

Table 2

ESTIMATED NUMBER OF YELLOW POPLAR SEEDLINGS PER ACRE (ALL AGES) BASED ON POPULATION OF QUADRATS

	Burned Area		Unburned Area	
Year	Cleared	Not Cleared	Cleared	Not Cleared
1925	35,741	32,636	2,360	1,324
1926	9,234	9,467	1,270	1,463
1927	900	2,381	73	355
1929	1,118	2,714	897	4,976
1931	283	798	544	1,575

In general, the distribution of seedlings present was satisfactory. In 1927 and 1929, on the burned uncut area, there was a tendency toward concentration of seedlings on a few quadrats, and in 1929 a similar tendency was noted on the unburned uncut quadrats. Otherwise, changes in the per cent of quadrats bearing seedlings tended to follow closely variations in number of seedlings present. The only time that all the quadrats under any of the four conditions bore seedlings occurred at the first examination on the burned areas.

The large numbers of yellow poplar seedlings present at the first examination precluded the tagging of individuals so it was planned that tagging should be delayed for a few years until dominance was expressed. Subsequent examinations prior to 1931, however, disclosed no yellow poplars as much as 6 inches high. Successful yellow poplar seedlings usually show rapid juvenile growth and this led to the belief that a constant turnover in seedlings was taking place, in the uncut areas, as well as under the dense fern cover. Accordingly, in 1929 and 1931 the seedlings of the current year (identified by the presence of cotyledons) were tallied separately from those established previously. The results, presented in Table 3, show that by far the greater number originated during the current year. The only exception is found on the clear-cut and burned area.

At the time of the 1931 examination yellow poplar seedlings more than 6 inches high were present on the burned clear-cut area at the rate of 87 per acre and on the unburned clear-cut area at the rate of 36 per acre. No seedlings more than 6 inches high were found on the other two areas. Of the seedlings greater than 6 inches tall, only one has succeeded in overtopping the fern growth.

Discussion

Root competition and shading are probably the primary causes of failure of the yellow poplar seedlings to develop. These causes are operative under all conditions observed in this experiment. On the clear-cut areas, both burned and unburned, the ferns monopolize the upper soil layers and completely shade the ground except-

Fig. 2.—Sprout growth, chiefly of red maple, in August, 1931, six years after the area was burned and clear cut.

Fig. 3.—Dense fern growth such as this prevented the successful establishment of yellow poplar reproduction.

ing immediately under the sprout clumps. Seedlings on the uncut quadrats are subjected to the root competition and shading of the existing stand of trees which forms practically a complete crown canopy.

Other possible causes of the heavy mortality include drouth and grazing. The entire Southern Appalachian region suffered a severe drouth in 1925 when even large trees on the upper slopes and ridges succumbed. The drouth may have augmented the losses due to competition between 1925 and 1926, but can hardly explain the continued mortality observed in 1927. Similarly the 1930 drouth may account for part of the losses occurring since 1929. Although the quadrats are accessible to deer and cattle, no grazing or browsing damage has been noted in any examination.

Still another cause for failure of the seedlings that may be operative is the inherent lack of vigor of the great bulk of the newly established plants. Observations made on the Bent Creek Experimental Forest indicate that tremendous losses occur in year-old yellow poplar seedlings even under favorable conditions. Those plants which fail to survive more than a year or two seldom attain a height of more than 3 inches. In nursery beds, with good care, yellow poplar seedlings sometimes attain a height of as much as 10 inches in one year. It is likely that more detailed studies of the behavior of individual seedlings will indicate a minimum height that must be reached the first year if the plant is to survive and retain a place in the stand.

The marked changes occurring in number of seedlings per acre from year to year indicate the futility of attempting to judge the adequacy of yellow poplar reproduction from a single year's count of all seedlings under conditions of severe competition.

The evidence from these plots clearly indicates that surface burning promotes germination of yellow poplar and facilitates its establishment the first year. It would also appear from Table 2 that the advantage, in numbers, gained by burning clear-cut areas persisted for 4 years after the fire. When no clearing is done, however, the advantage appears to be lost after 2 years. Such advantages would doubtless be of great value under favorable conditions of competition. That fire is not necessary to obtain an adequate stocking of yellow poplar on these areas is evidenced, however, by the fact that on the unburned quadrats a satisfactory number of seedlings has been present at all but one examination.

No attempt was made at the time the experiment was started to ascertain with certainty the source of the seed from which the seedlings originated. The 1924 seed crop was heavy, but the bulk of the seed shed during the winter was probably consumed by the fire. Two other possible sources for the seed were: (1) the 1923, and possibly an earlier, crop stored in the duff; and (2) seed that remained on the trees and was shed after the fire.

The case in favor of clear cutting to favor yellow poplar reproduction is less convincing on these plots than that in fa-

TABLE 3

NUMBER OF YELLOW POPLAR SEEDLINGS PER ACRE BY YEAR OF ORIGIN. JULY, 1929, AND OCTOBER, 1931

Time of Examination	Burned Area: Clear Cut: Current year	Burned Area: Clear Cut: Previous years	Burned Area: Uncut: Current year	Burned Area: Uncut: Previous years	Unburned Area: Clear Cut: Current year	Unburned Area: Clear Cut: Previous years	Unburned Area: Uncut: Current year	Unburned Area: Uncut: Previous years
July, 1929	392	726	1756	958	762	135	4106	870
October, 1931	44	239	667	131	363	181	871	704

vor of burning. A greater number of seedlings was present on both the clear-cut areas immediately after cutting than on the corresponding uncut-areas, but this advantage persisted only one year. In every succeeding examination of the plots the uncut areas bore a larger number of seedlings than the clear-cut areas.

The sudden loss of the advantage held by the clear-cut areas was probably due to the fact that the cutting benefited the ferns more than it did the seedlings. This is borne out by the data for both burned and unburned areas. The commonly accepted idea that bare mineral soil is required for the successful establishment of yellow poplar may reflect the species' tolerance of competition more than it does the actual seed bed requirements. Experience on these plots shows the advisability of considering the effects of environmental changes, such as cutting, on all vegetation present.

Summary and Conclusions

The establishment and survival of yellow poplar seedlings was observed on quadrats under the following conditions: (1) clear cut and burned; (2) clear cut, but not burned; (3) burned, but uncut; (4) neither burned nor cut.

For four years a greater number of seedlings per acre was found on the burned than on the unburned areas, both cut and uncut. This condition was reversed in the sixth year.

The first year after treatment th cleared areas had more seedlings per acr than their respective uncut areas. All sub sequent examinations showed the opposit to be true.

At the end of the seventh growing sea son yellow poplar seedlings taller than inches were present at the rate of 87 pe acre on the clear-cut burned area and 3 per acre on the clear-cut unburned quad rats. No yellow poplars taller than inches were found on the uncut quadrats Only one seedling on all the quadrat has become as tall as the fern growth in seven growing seasons.

Observations during the fifth and seventh growing seasons after establishment o the quadrats showed, on all quadrats ex cept those clear cut and burned, that th majority of seedlings present germinate during the current year. A regular turn over in seedlings appeared to occur on the plots.

The adequacy of existing yellow poplar reproduction cannot be judged from a single year's count of all seedlings. The minimum vigor of seedlings, as measured by first year's height growth, necessary to overcome various degrees of competition should be determined by further studies.

In the situation here reported, in which a dense growth of fern developed after cutting and burning, the most obvious cause of failure of the yellow poplar seedlings to develop is the root and light competition offered by fern growth and existing stand.

THE USE OF PAPER MULCH IN THE FOREST NURSERY AND FIELD PLANTATIONS

By P. W. ROBBINS[1]

Michigan State College, East Lansing, Mich.

The use of paper mulches by some agriculturists for improving growth and reducing weeding costs has suggested their use in forest nurseries. The author of this paper experimented with paper mulches in his forest nursery but found no sum total advantage when used on transplants. His method and conclusions are reported here.

PAPER COMPANIES and individuals have been claiming more rapid growth, higher survival and lower production costs for truck garden crops and trees when planted through paper. State agricultural experiment stations have conducted experiments and published results for paper-mulched garden crops, (1, 2, 3). However, the benefit claimed for trees, which have been grown through paper, have been based largely on observations and few figures are available upon which to base conclusions. T. J. Starker (4) in his experiments with veneer, straw, leaves, sawdust and paper for mulching nursery transplants at Oregon State College, found that paper-mulched plots were not as satisfactory as cultivated or leaf-mulched plots for the production of Douglas fir transplants in the forest nursery.

In order to determine if the use of paper mulch in the production of forest nursery transplants is practical and beneficial experimental plots were set out in 1929, 1930 and 1931 at the forest nursery of the Dunbar Forest Experiment Station near Sault Ste. Marie, Michigan. This region has an annual rainfall of 29.61 inches and a growing season of from 130 to 140 days. The soil is very fine sandy loam, with no stones or gravel. Due to the compactness of the silty substratum the natural drainage is slow.

The experimental plots consisted of two blocks of 5,000 trees, one paper-mulched and one check plot. The seedlings used were 2-0 white pine, which had four- to six-inch tops and roots of approximately the same length. In this article only the 1930 plots are considered, because the St. Marys River flooded the 1929 plot and destroyed many of the trees. The 1931 plots are not considered because the results will not be available until 1932.

The seedlings on the mulched plot were set two inches apart in the row and six inches apart between rows. The seedlings on the check plot were spaced two inches apart in the row and 14 inches apart between rows, which is the customary spacing for 2-2 stock at this nursery. The plant paper used in this experiment was purchased from the Simplex Paper Corporation of Adrian, Michigan at a cost of five dollars per roll. The rolls weighed approximately 60 pounds, were 18 inches by 900 feet and contained 1,350 square feet. This plant paper was made of two thin sheets of paper cemented together with asphalt. In order to plant the seedlings through the paper with a trencher and transplant board, a continuous cut would have been made through the paper. Planting along the edge of the paper would make the rows 18 inches wide, which is a wider spacing than is generally used for transplants. The spacing between transplant rows is generally regulated by the width of the cultivating machinery used in the nursery. Paper mulched trees

[1]Research Forester in charge of the Dunbar Forest Experiment Station, Department of Forestry Experiment Station of the Michigan State College, East Lansing, Michigan.

require no cultivating and therefore the rows may be closer together than the rows of cultivated trees. In order to conserve the paper and ground area, the 18-inch rolls were cut into narrower rolls. In 1929 this was done by sawing the rolls in half, but this was a slow and tedious job as the asphalt gummed up the saw teeth. In 1930, the rolls were split into three strips six inches wide with the aid of two sharpened pieces of a hack saw blade set in a frame above the rack from which the paper was unwound. The paper was cut as it unwound. This method of cutting the paper was rapid and very satisfactory.

The planting method used for the paper-mulched plot consisted of opening the ground with a trencher along a guide string for the first row and setting the seedlings. Then a strip of paper was rolled out on each side of the row and pushed tight against the trees. The edges of the paper were then covered with earth to hold them in place. The edge of the paper formed the guide for the trencher for the next row and thus took the place of a guide string. The unmulched plots were planted by using a trencher and transplant board.

The average weight per transplant and the relative root and top lengths in Table 1 were secured from 100 paper mulched and 100 non-mulched trees which were dug from rows where the conditions appeared uniform and average for the plots. The trees were carefully lifted with spades and the entire mass of trees and earth was set in a pan of water and the dirt slowly washed from the roots. The tops and roots were measured and then oven dried and weighed. The cost of mulch paper per thousand trees was computed from the total cost of the paper, including freight charges. In computing the number of square feet of paper used, only six inches was considered the width per row, for no matter how many rows are set out only one additional strip of six inch paper would be used.

Table 1 shows that the weeding and cultivating costs for the mulched plot was forty cents less per thousand trees than for the unmulched plot. The planting cost per thousand is higher for the mulched plot, due to the additional time required to set and weight down the paper. Weeding was necessary the first year between the transplants in the rows on both the mulched and check plot. The second year one weeding in the row was necessary on the check plot. The paper prevented all weed growth between the rows on the mulched plot. The paper was in good condition at the end of the second year, but on the 1929 plots it had begun to disintegrate at the end of the third year. The increased cultivating and weeding costs for the check plot almost offset the increase in cost of producing trees in paper. The relative sizes above ground and the length of roots were greater for the unmulched transplants, while the average dry weight of the paper mulched trees was 1.005 grams greater than the

TABLE 1

PRODUCTION COSTS, SIZES AND DRY WEIGHTS OF PAPER-MULCHED AND CULTIVATED WHITE PINE TRANSPLANTS, 2-2 STOCK

	Planting cost per thousand	Weeding cost per thousand		Cultivating cost per thousand		Paper cost per thousand	Total cost per thousand	Relative size in inches		Average dry weight per transplant in grams, taken from 100 transplants
		1st yr.	2nd yr.	1st yr.	2nd yr.			Top	Root	
Not mulched	.96	.16	.08	.20	.12		1.52	11.60	11.52	10.386
Mulched	1.08	.16	----	----	----	.34	1.58	11.59	11.44	11.391

average dry weight of the unmulched trees. From observations, the author believes the increased weight was in the roots for the mulched transplants appeared to have a more bushy root system.

The biggest problem encountered in the use of plant paper was to keep it in place. A strong wind will blow the paper away from the trees if it is not anchored properly. The ends and edges of the paper should be completely covered with one-half to three-fourth of an inch of soil. This soil holds the paper in close contact with the ground and prevents any weed seeds under the paper from germinating and growing out around the edge. The ground between rows should have a convex shape to aid rainwater in running to the edge of the paper and to reach where it will benefit the trees. If the paper surface is concave, it will hold the precipitation from light rains and allow it to be lost by evaporation. The transplant beds at this nursery are never watered after the trees are planted. No severe loss of transplants occurred in either of the plots and from observations it appeared that the plots were equal in survival.

Tentative Conclusions

Paper mulching of nursery transplants prevents the growth of weeds in the mulched rows and greatly reduces the cost of cultivation, but the reduction in weeding and cultivating costs is not great enough to offset the cost of the paper and the increased planting cost. Paper mulching increases the total dry matter produced and produces a better tree, for the total dry matter is the most reliable measure of the growth of a transplant. Paper mulching does not produce transplants which are outstandingly superior in size in comparison to non-mulched trees. Production costs in producing transplants in mulch paper are higher and would prohibit the use of paper in localities where cheap labor can be secured and where the transportation costs on the paper would be high. Paper mulching 1-1 or 2-1 transplants is not practical for the benefits from the reduced weeding and cultivating costs for the second year would be lost. The reduction in the cost of mulch paper from five dollars in 1929 to three dollars in 1931 per 1,350 square feet and the saving of one-half the ground area would make it practical and beneficial to produce nursery transplants in paper at the present time, especially in nurseries where ground space and labor are at a premium.

The Use of Paper Mulch in Field Plantations

In October 1929, a field planting experiment using a paper mulch around each tree was started at the Dunbar Forest Experiment Station. The planting was in a portion of a heavy quack grass sod area, which had previously been planted in 1927 with 5,000 Norway spruce 2-0 seedlings. The 1927 planting was made in deep horse-plowed furrows. The survival for this plantation in 1929 was 64.46 per cent.

The 1929 planting was started to determine whether a paper mulch placed around each seedling in field plantations would kill the heavy sod and relieve the seedling from competition with the grass and increase the survival of the trees. Nine hundred and forty-seven 3-year-old Norway spruce seedlings were spot planted with a grub hoe six feet apart in the rows and eight feet apart between rows. A one-foot-square of old roofing paper was placed around four hundred and seventy-one trees.

The paper was prepared by cutting old tar-paper roofing into one-foot squares. A hole was punched in the center of each square and a slit cut from the outside edge to the hole. The paper was applied immediately after planting by sliding it over the tree along the cut and into the

hole in its center. The paper was held in place and in close contact with the soil by weighting down the edges with clumps of sod. The author is not positive that tar paper does not have a detrimental effect upon the soil under it, but in this case the paper was old and weathered and probably did not harm the trees.

On June 26, 1931, the trees were counted and the survival was found to be 52.35 per cent for the paper mulched trees and 55.32 per cent for the non-mulched trees. The spot planting in 1929 without mulch paper cost $7.94 per acre and the spot planting using paper around each tree cost $28.13 per acre. The same number of trees per acre were planted on all three plots. The planting cost of $28.13 per acre included the cost of preparing the paper but no charge was made for the paper as it was salvaged from a wrecked building. If the paper had been purchased, the additional cost would have been $2.83.

Conclusions

The low survival and the extreme hig cost of $28.13 per acre for establishin field plantations with paper mulch aroun each tree does not warrant the use of pa per mulch in forest field plantations, es pecially since a plantation was establishe on the same area at a planting cost c $4.11 which gave a survival of 64.46 pe cent in comparison with 52.35 per cen for the paper-mulched trees.

References

1. Edmond, J. B. 1929. Mulch paper fo vegetable crops is tested. Michiga Agri. Sta. Bull., Vol. 11, No. 3.
2. Magruder, Roy. 1928. Paper mulch fo the garden. Ohio Agri. Exp. Sta. Bull Vol. 13, No. 4.
3. ————. 1929. Paper mulch result at Marietta. Ohio Agri. Exp. Sta. Bul No. 150, 1931.
4. Starker, T. J. 1931. Mulching nurser transplants. Jour. of For., 29:238-240

"In our western tour across the continent, no feature of the landscape appears more remarkable, after passing the Mississippi to the wide alluvial borders of the Platte, than the almost total absence of our most characteristic forest trees, the Oaks. When at length, we approached the Rocky Mountains or Northern Andes, we looked in vain for any species of this important genus and as far as the eye could trace we commonly saw nothing but dark unbroken mass of Gigantic Firs and Pines. It was not till we had nearly reached the shores of the Pacific, that we again beheld any of the familiar features of the Atlantic forest. At the confluence of the Columbia and the Wahlamet we pitched our tents and moored our vessel, which had passed Cape Horn beneath the spreading shade of majestic Oaks. With the first appearance of extended alluvial plains, immediately below the singular falls of the Oregon, called the Dalles, or Dykes, we observed, for the first time, this western oak loaded with its fruit."

The North American Sylva, Thomas Nuttall. 1849.

DOES LIGHT BURNING STIMULATE ASPEN SUCKERS? II

By HARDY L. SHIRLEY

Lake States Forest Experiment Station, St. Paul, Minn.

In an earlier article the author reported that light burning caused a significant increase in the production and growth of aspen root suckers. His present paper supplements the first and tends to support the original hypothesis that this stimulation is due to the increased heat absorption of the blackened surface. The data presented indicate that the stimulation disappears after the first year.

IN A PAPER[1] bearing the same title, a definite stimulation in both numbers and height growth of aspen suckers was reported as a result of a light surface fire. The suggested cause of this stimulation was the increased heat absorption of the blackened surface. If this suggestion is correct, then the burned and unburned areas should grow at the same rate the second year when the leaves from the first-year suckers have covered the burned surface with some allowance for increased competition where the sprouts were at first more numerous.

Accordingly, the same quadrats were remeasured at the end of the 1931 growing season. The results are shown in Table 1. The average height of the suckers on the clear-cut area is practically the same on burned and check quadrats, indicating that on this area, which is exposed to full insolation, the advantage of the burned surface had disappeared. The numbers of suckers per quadrat remain in about the same proportion as at the end of the first year.

On the partially cut area, the suckers on the burned quadrats continue to outgrow those on the check quadrats. The temperature effect would be less likely to be important in this case. For the uncut plot, growth is better on the check quadrats. When the results from the partially cut area are combined with those from the uncut area, the differences in both numbers of suckers and heights are no longer significant. Since these two areas showed opposite trends individually, it is felt that a more reliable estimate is gained by combining them.

Temperature readings were taken once a week on burned and unburned quadrats in a jack pine stand subjected to three degrees of cutting to see if the temperatures were actually higher on the blackened soil. On the two plots subjected to heavy cutting the burned quadrats were slightly warmer, both at the surface and at eight inches depth. The differences were not statistically significant, but probably would have been, had more temperature readings been taken. On the lightly cut and uncut plots, temperatures were essentially the same on burned and check quadrats. Temperature differences were greater in the spring than later when both burned and check quadrats were covered with vegetation.

It may be concluded, therefore, that light burning does stimulate the numbers and rate of growth of aspen suckers on heavily cut areas for the first growing season following burning. This stimulation disappears after the first year. Additional evidence tends to support the original suggestion that this stimulation is due to the increased heat absorption of the blackened surface.

[1]Shirley, Hardy L. Does Light Burning Stimulate Aspen Suckers? Jour. Forestry 29: 524-525. 1931.

TABLE 1

ASPEN ROOT SUCKERS ON BURNED AND UNBURNED QUADRATS AT END OF SECOND YEAR

1931

Datum	Clear-cut area		Partially-cut area		Uncut area		Uncut & partially-cut together	
	Burned	Check	Burned	Check	Burned	Check	Burned	Check
Number of suckers per quadrat (Mean of 4)	67.8	43.8	5.5	3.0	1.5	2.2	3.5	2.6
Excess in favor of burned	24.0	——	2.5	——	— .7	——	.9	——
Equivalent number per acre	29,500	19,100	2,400	1,300	650	960	1,520	1,130
Mean height of suckers, feet	5.68	5.63	3.77	2.80	2.50	3.55	3.50	3.12
Increase on burned, feet	.05	——	.97	——	—1.05	——	.38	——
Maximum height of suckers, feet	13	11	7	5	5	6	7	6
Odds, burned exceeded check								
In Numbers	100 to 1		100 to 2		70 to 100		100 to 30	
In Height	100 to 80		100 to 2		20 to 100		100 to 40	

THE DRYING RATE OF HARDWOOD-FOREST LEAVES

By M. E. DUNLAP

Senior Engineer, Forest Products Laboratory[1]

This article sets forth the results of recent experiments to determine the drying rates of loose hardwood leaves of 12 species under humidity and air conditions considered typical of those obtaining in the forest. It was found that loose leaves may reach a stage of inflammability within an hour.

THE FOREST Products Laboratory, in coöperation with the Central States Forest Experiment Station, has studied the drying rate of loose leaves of 12 species of hardwoods, under a relative humidity and an air current that may be considered typical of forest conditions in the fall and the late spring. The change in equilibrium moisture content of the leaves with change in relative humidity was also determined. The leaves, collected in Ohio in May, were presumably the growth of the previous year.

The leaves examined came from the following species:

Beech (*Fagus grandifolia*)
Sweet birch (*Betula lenta*)
Chestnut (*Castanea dentata*)
Shagbark hickory (*Hicoria ovata*)
Red maple (*Acer rubrum*)
Sugar maple (*Acer saccharum*)
Blackjack oak (*Quercus marilandica*)
Chestnut oak (*Quercus montana*)
Northern red oak (*Quercus borealis*)
Pin oak (*Quercus palustris*)
Red oak (*Quercus borealis maxima*)
White oak (*Quercus alba*)

A supply of leaves sufficient for one day's work was soaked in water overnight, and surplus moisture was removed through centrifugal action just before the experimental work. After weighing, the leaves, spaced about 1.5 inches apart, were spread out between pieces of ordinary fly screening and then so placed in an air current of approximately 5 miles an hour that both surfaces of each leaf were exposed to the air but only one was subjected directly to its flow. They were reweighed at intervals; the drying was continued until they no longer lost weight. All this work was done under relative humidities of about 30 per cent and a temperature of about 80° F.

After this drying the leaves were subjected in turn to relative humidities varying from 20 per cent or less to more than 90 per cent, and then back to the low limit again; they remained at each value for at least 24 hours. Weights were determined at the end of each conditioning period. The leaves were then dried to constant weigh, which was considered the value oven-dry.

Figure 1 shows the rate or drying in the air current. It indicates that loose hardwood leaves, under conditions favorable to drying, may reach a stage of inflammability within an hour. The initial moisture content of the leaves was high, probably about the same as the moisture content in the forest after several days of rain, so that the conclusion is conservative.

Figure 2 gives the variation of the equilibrium moisture content of the leaves with change in relative humidity, in maximum, average, and minimum curves. The average values appear to be much higher than the corresponding values for wood.

In many parts of the United States drying conditions during the summer will

[1]Maintained at Madison, Wis., in coöperation with the University of Wisconsin.

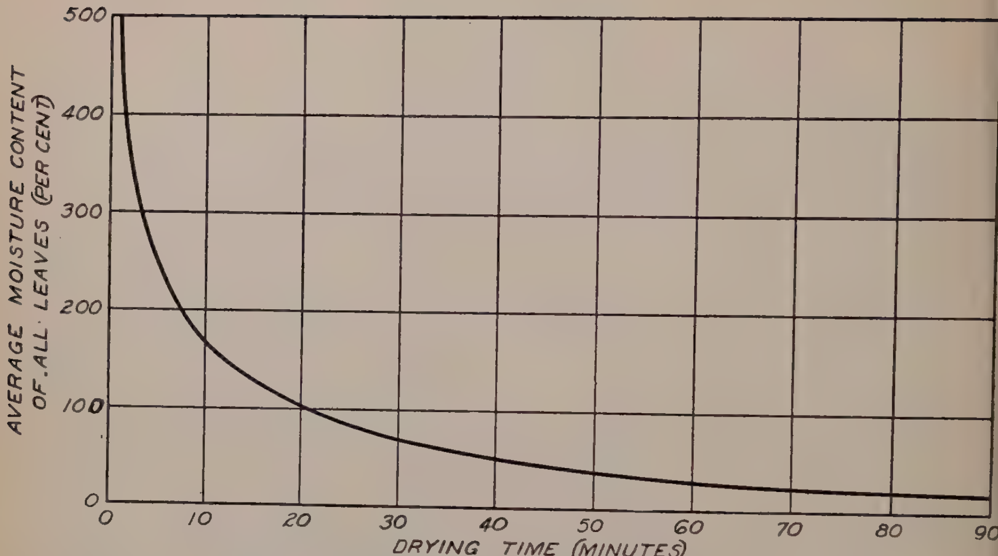

Fig. 1.—The drying rate of loose leaves of 12 hardwoods.

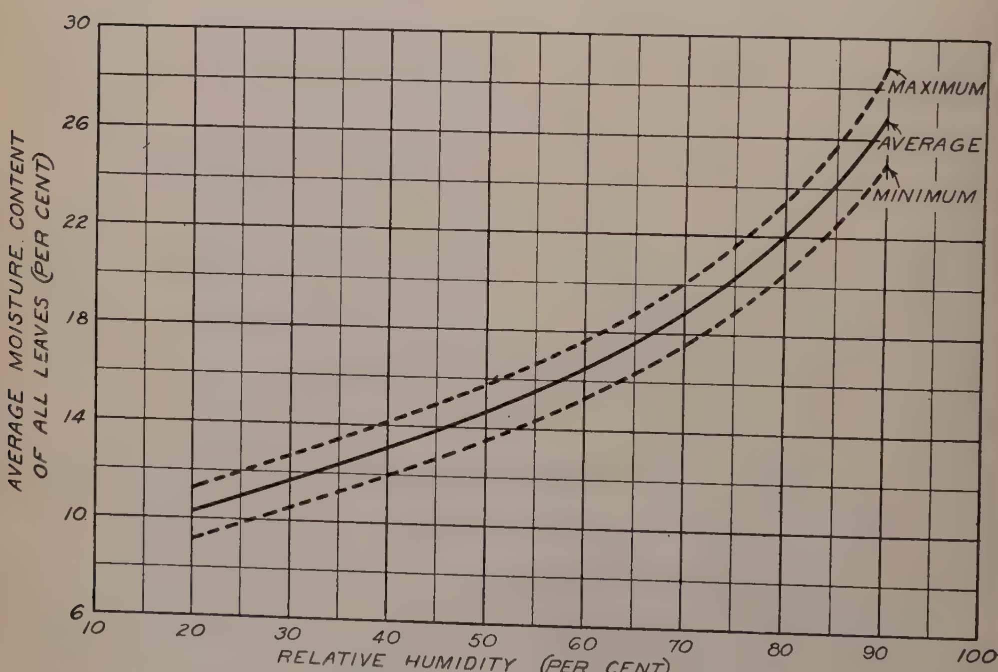

Fig. 2.—The equilibrium moisture content of hardwood leaves.

be far more favorable than those of these experiments, and in most places the retardation of decay will presumably be insufficient to offset them. Hence the conclusions drawn from the study may reasonably be applied extensively rather than restrictedly. The chief condition in actual forests that will perhaps tend to increase the drying time over the time determined in the study will be the total amount of moisture for a drying wind to carry away; the experimental work, for instance, did not include the simultaneous drying of tree trunks, undercover, and standing water as well as leaves. Even so, the leaves used were so extremely wet that the conclusions still appear conservative for average conditions in all parts of the country. The primary application, of course, is in fire protection, and yet run-off studies, for example, may make some use of the findings.

"A forester then is not, as the American public has been prone to apply the word, one who knows the names of trees and flowers, a botanist; nor even one who knows their life history, a dendrologist; nor one who, for the love of trees, proclaims the need of preserving them, a propagandist; nor one who makes a business of planting parks or orchards, an arboriculturist, fruit grower, landscape gardener, or nurseryman; nor one who cuts down trees and converts them into lumber, a wood chopper or a lumberman; nor one set to prevent forest fires or depredations in woodlands, a forest guard; nor even one who knows how to produce and reproduce wood-crops, a silviculturist; but in the fullest sense of the term, a forester is a technically educated man who, with the knowledge of the forest trees and their life history and of all that pertains to their growth and production, combines further knowledge which enables him to manage a forest property so as to produce certain conditions resulting in the highest attainable revenue from the soil by wood-crops."

Economics of Forestry, Bernhard E. Fernow. 1902.

WHAT IS THE GROWTH PER CENT OF AMERICAN FORESTS?

By H. F. MOREY

Junior Forester, Allegheny Forest Experiment Station[1]

Growth per cent was computed for 17 American species for the age at which mean annual growth in board feet culminated. The rates of growth at this age ranged from 7.7 per cent for cottonwood in the Mississippi Valley to 0.8 per cent for lodgepole pine in the Rocky Mountains.

A RECENT STATEMENT that "there is no forest in this country, except possibly the swamp forest of the northern Lake States, which is not earning through growth alone, without the effort of man, from 2.5 to 3 per cent" (20), has made some of us sit down and think.

The writer does not know to what this figure of "2.5 to 3 per cent" refers. Mr. Zon, in the paragraph preceding this statement, was speaking in terms of dollars, so his statement may refer to financial return. However, "earning through growth alone," might also lead one to believe that the statement referred to volume growth. The results of this study indicate that the statement in question referred to financial returns.

The recent revision of the Capper report gave an opportunity for comparing the growth per cents attained by various species in the Allegheny region at arbitrarily selected rotation ages. These figures are not used in this paper because the writer felt that they did not offer a fair comparison; the arbitrary rotation age was not necessarily the age at which the mean annual growth culminated, neither was it necessarily the financial rotation age. Growth per cent is inversely proportional to age (2). This is shown very plainly for loblolly pine (Table 1), the growth per cent of which, based on cubic-foot volumes, varies from 7.5 in 20-year old stands to 0.4 in 80-year.

Since so many factors affect the financial rotation age, which is the true age at which the stand should be cut, the growth per cent was based on the age at which mean annual increment culminated.[2]

Board foot volumes were used throughout. Whenever possible, the table chosen for the computations was based on the International ⅛-inch log rule, with the Scribner Decimal C as second choice. In some instances there was no choice of rule. It was assumed that the limits of utilization as given in the tables were the ones adhered to in that particular region or locality.

Since the length of period undoubtedly affects growth per cent, volume growth on average sites was used for the 5-year period previous to the culmination age. This necessitated interpolation in some tables whose yields were given at 10-year instead of 5-year intervals. These interpolations were made by curving the yield table values for the 10-year periods and reading the 5-year values from these curves.

The compound interest formula, $\rho = \left(\sqrt[n]{\frac{V}{v}} - 1 \right) 100$, of which the merits were discussed recently (9), was used for

[1]Maintained at Philadelphia, Pennsylvania, by the U. S. Forest Service, in coöperation with the University of Pennsylvania.

[2]The age at which the mean annual growth culminates is hereafter referred to as "culmination age" for the sake of brevity.

all computations. Per cent, p, in the factor $1.0p^5$ was obtained from the compound interest tables of Chapman (2).

An attempt was made to obtain growth per cent for most of those species for which yield tables were available. Unfortunately the culmination age for the northern hardwoods, the oaks, and a few other hardwoods, was greater than the maximum yield table age. For this reason cottonwood (*Populus deltoides* Marsh.) is the only hardwood for which a growth per cent is given here.

The growth per cents and other pertinent data are given for each of 17 species in Table 2. As shown in this table, the board foot growth rate on average sites for the 5-year period previous to the culmination age ranged from 7.7 per cent for cottonwood in the Mississippi Valley to 0.8 per cent for lodgepole pine (*Pinus contorta* Loud.) in the Rocky Mountains. It is interesting to note that the minimum and maximum culmination ages were respectively 35 years for cottonwood and 130 years for lodgepole pine. [The culmination age for Norway pine (*Pinus resinosa* Soland.) was also 130 years.]

There appears to be a great variation in the growth of northern white pine (*Pinus strobus* L.) as determined from different yield tables. This is to be expected since the average site in one locality may be an excellent or a poor site in another region. The range for this species was from 1.2 per cent in Wisconsin to 2.8 per cent in Massachusetts, the range in culmination age being respectively from 90 to 50 years. Two tables were available for the species in Massachusetts, the difference in growth rate and culmination age being respectively 0.8 per cent and 15 years.

There was very little difference in growth per cent between Douglas fir [*Pseudotsuga taxifolia* (Lam.) Britton] in California and Douglas fir in the Pacific northwest and between loblolly pine (*Pinus taeda* L.) in Maryland and loblolly pine throughout the southern pine region. The culmination ages, however, differed from 10 years for Douglas fir to 5 years for loblolly pine. Here again the relationship between growth per cent and culmination age is shown. For a given species, the table having the highest growth per cent has the lowest culmination age.

The relative growth rates of the various species are summarized in Table 3. Ten of the seventeen species had a growth rate of less than 2.0 per cent. Northern white pine, which is included in this class, is also included in the next class, 2.0 to 3.9 per cent, which is represented by six species. But two of the seventeen species, Virginia pine (*Pinus virginiana* Mill.) and eastern cottonwood, were growing at more than 4.0 per cent when they attained the age at which their mean annual growth culminated.

All of the species having a growth rate of 2.0 per cent or more were growing from the Mississippi Valley eastward. However, the lowest growth rate class had a fair representation of eastern species.

TABLE 1.

LOBLOLLY PINE—SITE INDEX 90, CUBIC FEET[1]

Age	Growth per cent
15	—
20	7.5
25	6.1
30	4.4
35	3.8
40	2.5
45	1.8
50	1.5
55	1.0
60	0.8
65	0.7
70	0.4
75	0.4
80	0.4

[1]Table No. 39.—Reference 17.

TABLE 2.

GROWTH PER CENT, AVERAGE SITES. BASED ON VOLUME GROWTH, BOARD MEASURE, FOR 5-YEAR PERIOD PREVIOUS TO AGE OF CULMINATION OF MEAN ANNUAL GROWTH

Species	Locality	Reference number to authority[1]	Log rule used[2]	Utilization limits	Age years of culmination of mean annual growth	Growth per cent
Cottonwood, eastern (*Populus deltoides* Marsh.)	Mississippi Valley	18	S. Dc.	?	35	7.7
Douglas fir (*Pseudotsuga taxifolia* [Lam.] Britton)	California	10	I-⅛	5″ Top	70	1.6
Douglas fir (*Pseudotsuga taxifolia* [Lam.] Britton)	Pacific Northwest	14	I-⅛	7″ D.B.H. +	80	1.4
Fir, balsam (*Abies balsamea* [L.] Mill.)	Northeast	15	I-⅛	7″ D.B.H. +	80	1.6
Pine, jack (*Pinus banksiana* Lamb.)	Lake States	16	I-⅛	4″ D.B.H. +	70	2.5
Pine, loblolly (*Pinus taeda* L.)	Maryland	4	Maine	8″ D.B.H. +	55	2.1
Pine, loblolly (*Pinus taeda* L.)	Southern Pine Region	17	I-⅛	7″ D.B.H. +	50	2.3
Pine, lodgepole (*Pinus contorta* Loud.)	Rocky Mountains	13	S. Dc.	6″ Top	130	0.8
Pine, longleaf (*Pinus palustris* Mill.)	Southern Pine Region	17	I-⅛	7″ D.B.H. +	75	1.5
Pine, northern white (*Pinus strobus* L.)	Massachusetts	3	M. T.	4″ Top	50	2.8
Pine, northern white (*Pinus strobus* L.)	Massachusetts	12	M. T.[3]	5″ D.B.H. +	65	2.0
Pine, northern white (*Pinus strobus* L.)	New Hampshire	5	M. T.	5″ D.B.H. +	75	1.4
Pine, northern white (*Pinus strobus* L.)	Wisconsin	6	I-⅛	7″ D.B.H. +	90	1.2
Pine, norway (*Pinus resinosa* Soland)	Lake States	19	S. Dc.	6″ Top	130	1.2
Pine, pitch (*Pinus rigida* Mill.)	Pennsylvania	8	M. T.-¼	?	50	3.4
Pine, shortleaf (*Pinus echinata* Mill.)	Southern Pine Region	17	I-⅛	7″ D.B.H. +	55	2.5
Pine, slash (*Pinus caribaea* Morelet)	Southern Pine Region	17	I-⅛	7″ D.B.H. +	45	3.0
Pine, Virginia (*Pinus Virginiana* Mill.)	Maryland	11	M. T.[4]	5″ D.B.H. +	30	4.3
Pine, western white (*Pinus Monticola* D. Don)	Northern Rocky Mountains	7	I-⅛	7″ D.B.H. +	120	1.1
Pine, western yellow (*Pinus ponderosa* Lawson)	Inland Empire	1	I-¼	4″ Top	100	1.1
Spruce, red (*Picea rubra* Link)	Northeast	15	I-⅛	7″ D.B.H. +	80	1.9
Spruce, white (*Picea glauca* [Moench] Voss)	Northeast	15	I-⅛	7″ D.B.H.I.	80	1.4

[1]Same number as used in list of references.
[2]Abbreviations I-⅛ = International ⅛ inch; I-¼ = International ¼ inch; S. Dc. = Scribner Decimal C.; M. T. = Mill Tally; M. T.-¼ = Mill Tally, ¼ inch kerf.
[3]Same rule as for white pine in New Hampshire.
[4]Same rule as for white pine in New Hampshire, minus 10 per cent, curved.

Summary

1. Growth per cent is inversely proportional to age.

2. Eastern cottonwood in the Mississippi Valley had the highest growth rate and lodgepole pine in the Rocky Mountains had the lowest growth rate at their respective ages of culmination of mean annual growth.

3. There was a great variation in the growth of northern white pine as determined from different yield tables applying to different portions of its range. This was not so true of Douglas fir and loblolly pine.

4. Eastern cottonwood and Virginia pine grew at a rate of more than 4.0 per cent; seven species grew at a rate of 2.0 per cent or more, and nine species grew at less than 2.0 per cent. This does not include northern white pine which occurred in both classes.

5. The species having the greatest growth rates grew in the eastern part of the United States, although some eastern species had a growth rate no better than the western species.

Table 3.

Relative growth rates by 2 per cent classes

0 to 1.9 per cent		2.0 to 3.9 per cent		4.0 to 5.9 per cent		6.0 to 7.9 per cent	
Species	Growth per cent	Species	Growth per cent	Species	Growth per cent	Species	Growth per cent
Red spruce, Northeast	1.9	Pitch pine, Pa.	3.4	Virginia pine, Md.	4.3	Eastern cottonwood, Miss. Valley	7.7
Douglas fir, California	1.6	Slash pine, Southern pine region	3.0				
Balsam fir, Northeast	1.6	White pine, Mass.	2.8				
Longleaf pine, Southern pine region	1.5	Shortleaf pine, Southern pine region	2.5				
White pine, N. H.	1.4	Jack pine, Lake States	2.5				
White spruce, northeast	1.4	Loblolly pine, Southern pine region	2.3				
Douglas fir, Pac. N. W.	1.4	Loblolly pine, Md.	2.1				
White pine, Wisc.	1.2	White pine, Mass.	2.0				
Norway pine, Lake States	1.2						
Western Yellow pine, Inland Empire	1.1						
Western White pine, N. Rocky Mountains	1.1						
Lodgepole pine, Rocky Mountains	0.8						

References

1. Behre, C. Edward, 1928. Preliminary yield tables for second growth western yellow pine in the Inland Empire. Univ. Idaho. Forest Experiment Station Bul. 1.
2. Chapman, Herman Haupt, 1924. Forest Mensuration. Second edition revised. New York.
3. Cook, Harold O. Forest Mensuration of the white pine in Massachusetts. Quoted by Frothingham, E. H., 1914. White pine under forest management. U. S. Dept. Agr. Bul. 13.
4. Cope, Joshua A., 1925. Loblolly pine in Maryland. Second edition. Univ. of Maryland. State Dept. Forestry. Baltimore.

5. Frothingham, E. H., 1914. White pine under forest management. U. S. Dept. Agr. Bul. 13.
6. Gevorkiantz, S. R. and Zon, Raphael, 1930. Second-growth white pine in Wisconsin. Univ. Wisc. Agr. Exper. Sta. Res. Bul. 98.
7. Haig, I. T., 1927. Yield and volume tables for the western white pine type in the northern Rocky Mountain Region. Preliminary report (not published). Northern Rocky Mountain Forest Experiment Station, U. S. Forest Service.
8. Illick, Joseph S. and Aughanbaugh, John E., 1930. Pitch pine in Pennsylvania. Penn. Dept. Forests and Waters, Res. Bul. 2.
9. Rudolph, Paul O., 1930. A comparison of several of the growth per cent methods of predicting growth. Jour. For. 28: 28-33.
10. Schumacher, Francis X., 1930. Yield, stand, and volume tables for Douglas fir in California. Univ. Cal. Agr. Exper. Sta. Bul. 491.
11. Sterrett, W. D., 1911. Scrub pine. U. S. Dept. Agr. Forest Service Bul. 94.
12. Tarbox, E. E. and Reed, P. M. Quality and growth of white pine as influenced by density, site, and associated species. Harvard Forest Bul. 7. Petersham, Mass.
13. Mason, D. T., 1915. The life history of lodgepole pine in the Rocky Mountains. U. S. Dept. Agr. Bul. 154.
14. McArdle, Richard E. and Meyer, Walter H., 1930. The yield of Douglas fir in the Pacific Northwest, U. S. Dept. Agr. Bul. Tech. Bul. 201.
15. Meyer, Walter H., 1929. Yields of second-growth spruce and fir in the northeast. U. S. Dept. Agr. Tech. Bul. 142.
16. U. S. Forest Service, 1928. Jack pine yields per acre in Michigan, Minnesota, and Wisconsin. Lake States Forest Experiment Station Tech. Note 3.
17. U. S. Forest Service, 1929. Volume, yield and stand tables for second-growth southern pines. U. S. Dept. Agr. Misc. Pub. 50.
18. Williamson, A. W., 1913. Cottonwood in the Mississippi Valley. U. S. Dept. Agr. Bul. 24.
19. Woolsey, Theodore S. and Chapman, Herman H., 1914. Norway pine in the Lake States. U. S. Dept. Agr. Bul. 139.
20. Zon, Raphael, 1931. The society comes of age. Jour. For. 29: 308-315.

"The largest trees of this towering pine (*Pinus strobus*) which I have seen, are on the borders of the Androscoggin near Paris in Maine, where they seem to emulate in elevation the vast Firs of the Oregon. In the vicinity of Portsmouth, I am informed by John Elwyn, Esq., a tree was cut down some years ago which measured 200 feet in height. Naugenheim also remarks, that from the size of two masts for 74 gun-ships, that he saw in the Plymouth dockyards, which measured in the whole piece 108 feet each, that such a tree must have been 200 feet long, and 5 feet or more in diameter."

The North American Sylva, Thomas Nuttall. 1849.

THE SUITABILITY OF REINEKE'S PLANIMETER METHOD FOR VOLUME DETERMINATIONS OF DELTA HARDWOOD SPECIES

By ROBERT K. WINTERS[1] AND PHILIP R. WHEELER[2]

Southern Forest Experiment Station

The authors analyzed the stem measurements of 96 second-growth Mississippi Delta trees of 12 common species to ascertain the suitability of the planimeter method for determining volume. The Smalian formula was used to determine the basic volume. The planimeter method was found to give consistently lower volumes by 1.22 per cent, but it was concluded that the planimeter method approached the effective volume more closely. The authors recommend the planimeter method for volume table construction for the Delta species. Mr. Reineke, the originator, discusses the application of his planimeter method by the authors in comments following the article.

THE METHOD of tree volume determination by planimeter, originated by Reineke[3] has for several years been successfully used in volume table construction. Due to the large crowns and very irregular stem form of the hardwoods of the Mississippi River Delta region , a test has been made to ascertain the suitability of this procedure in the tree-volume determinations on Delta hardwood species. This test comprises the analysis of the stem measurements of 96 second-growth north Louisiana trees of 12 common Delta species. Diameter outside bark and double-bark thickness measurements were made at a 2-foot stump height, 1, 2.5, 4, 6.15 feet—and thereafter by 4.075 foot intervals, above stump height. Diameters were measured to the nearest one-tenth inch with calipers by averaging two readings taken at right angles to each other. Bark thickness was measured to the nearest 0.05-inch by a Swedish bark borer or, on species having very hard bark, by a scale inserted in a cut in the bark made with a hand axe. Two bark-thickness determinations were made at each point of diameter measurement, and twice the average of the two readings was entered as the double bark thickness at the given height. Tree heights were measured to the nearest foot with a steel tape. Since the hardwood species common in the Delta region do not have a characteristic monopodial stem, the diameter measurements above the base of crown were made upon one of the important ascending branches.

Smalian's formula, $V = \dfrac{b + B}{2} \times L$,

applied to short tree sections, was used to compute the basic tree volume inside bark. In this formula b and B are the basal areas of the top and bottom of the sections, respectively; L is the section length; and V is the section volume. The length of sections in the region of root swell varied from 1.0 foot to 2.15 feet as indicated in the first paragraph. Above the height 6.15 feet above the stump, the section length were uniformly 4.075 feet. The stump volume was determined by considering it as a cylinder 2 feet high having a diameter equal to the stump diameter of the tree. The volume of the tip of the tree, above the highest point of diameter measurements, was computed by treating this stem section as a cone. Tree volumes inside bark were summarized by

[1]Assistant Silviculturist.
[2]Junior Forester.
[3]Reineke, L. H. 1926. The Determination of Tree Volume by Planimeter. Jour. For. 24: 183-189.

species and entered in column 4, Table 1.

As one step in the determination of the planimetered tree volume, diameters inside bark were plotted on basal area-height paper (Forest Service Form 558-a) at the following heights above ground: 2 feet (stump height), 3, 4.5, 6, 18.3, 34.6 feet, etc., by 16.3-foot intervals to the tip of each tree. The points representing the inside bark diameters were connected by a smooth curve that was made to pass through each point. The inside bark stem volume for each tree was determined by planimetering the area beneath the inside bark curve. These volume determinations were made, summarized by species, and recorded in column 5, Table 1.

Tree volumes determined by the use of Smalian's formula were considered as bases, and the deviation of each planimetered volume from its corresponding basic volume was calculated. The average of these deviations by species is recorded in column 6, Table 1. The difference between the aggregate planimetered volume of trees of a given species and the aggregate basic volume of the same trees, expressed as a percentage of the latter, is given in column 7, Table 1.

It is apparent that the aggregate deviations by species are predominantly negative, and the average aggregate deviation for all species is –1.22 per cent. The deviation of the typical stem form of Delta hardwood species from the more or less regularly tapered ideal stem form accounts, in part, for this difference. The stem curve of many of the hardwood species exhibits a more or less "stair-stepped" condition, and in some instances assumes a "saw-toothed" form. The stem curve of willow oak (*Quercus Phellos*) shown in Figure 1 illustrates this condition and shows that the planimetered volume of this tree must be less than the volume calculated by the use of Smalian's formula. Casual observation might indicate that if the form of a sufficient number of trees were compared, the aggregate stem volumes by the two methods would agree. This condition could exist only if the plotted points through which the smooth curve was passed were as likely to fall on a peak as elsewhere. There are fewer peak points than others. As a result, the planimetered volume is predominantly smaller than the volume obtained by the use of Smalian's formula.

In Figure 2 is shown diagramatic representation of the stem form of a portion of the hardwood tree shown in Figure 1. The dotted horizontal lines indicate the 4.075-foot and other measuring points used in the determination of volumes by the use of Smalian's formula. Measuring points numbered 6, 10, and 14 correspond to the points through which the smooth curve of Figure 1 was passed. It can readily be seen that peak points on the curve of Figure 1 correspond to swells in the stem caused by branches, and that if all of the points through which the stem curve as illustrated in Figure 1 was passed had been peak points, the planimetered volume would have exceeded the volume obtained by use of Smalian's formula. If all the points through which the stem curve was passed had been valley points, the planimetered volume would have been smaller than the volume obtained by the use of Smalian's formula.

The use of the planimeter method of volume determination gives an expression for the volume of wood in the main stem only. An approximation of the amount of limbwood was obtained by dividing all branches into 4-foot sections and calipering the diameter midway between the section ends. Treating each 4-foot section as a cylinder having a diameter equal to the mid-diameter, cubic volumes of limbwood including bark were computed. Nc section was considered, the mid-diameter of which was not 4.0 inches or greater. The aggregate volume of limbwood by species was expressed as a percentage of

TABLE 1

SUMMARY OF RESULTS OBTAINED IN VOLUME STUDY OF DELTA HARDWOODS

Species.	Average d.b.h.	Average height.	Total volume inside bark by Smalian's formula.	Total planimetered volume inside bark.	Average deviation of planimetered volume from volume by Smalian's formula expressed as a percentage of the latter.	Aggregate deviation of planimetered volume from volume by Smalian's formula expressed as a percentage of the latter.	Volume limbwood outside bark.	Average volume of limbwood expressed as a percentage of volume by Smalian's formula.	Total volume to 10-inch top by Scribner rule.	Total volume of merchantable material by Scribner Decimal C dule.	Aggregate deviation of volume of merchantable material from volume to 10-inch top expressed as a percentage of the latter.	Volume of utilized material by Scribner Decimal C rule.	Aggregate deviation between utilized volume and volume 10-inch top expressed as a percentage of the latter.	Basis number of trees.
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Inches	*Feet*	*Cu. ft.*	*Cu. ft.*	*Per cent*	*Per cent*	*Cu. ft.*	*Per cent*	*Bd. ft.*	*Bd. ft.*	*Per cent*	*Bd. ft.*	*Per cent*	*Number*
Red gum	22.4	108	2,042.4	2,008.8	2.85	-1.65	378.7	18.54	10,271	8,470	17.53	7,620	25.81	20
Nuttall's oak	20.8	94	1,117.3	1,105.4	2.04	-1.07	272.0	24.34	5,267	4,400	16.46	3,450	34.50	15
Willow oak	26.0	100	1,373.8	1,353.4	1.99	-1.48	624.2	45.44	7,362	6,360	13.61	5,730	22.17	11
Lowland black oak	24.5	103	880.4	874.4	2.75	-0.68	185.0	21.02	4,800	2,750	42.71	2,570	46.46	7
Hackberry	17.5	82	602.3	595.7	2.04	-1.10	91.2	15.15	2,440	2,210	9.43	1,780	27.05	12
Green ash	19.0	84	194.0	193.0	1.65	-0.52	19.8	10.21	727	670	7.84	630	13.34	4
White elm	16.7	77	218.9	221.0	2.88	+0.96	45.8	20.92	891	680	23.68	610	31.54	5
Sweet pecan	21.1	97	830.7	817.1	3.05	-1.64	401.3	48.31	4,113	3,500	14.90	2,550	38.00	10
Bitter pecan	20.5	102	154.7	156.5	2.97	+1.16	31.6	20.43	739	500	32.34	420	43.17	2
Cottonwood	21.8	103	239.2	239.4	1.34	+0.08	44.4	18.56	1,167	1,150	1.46	1,040	10.88	3
Sycamore	26.4	97	386.5	380.9	1.42	-1.45	92.2	23.86	2,013	1,660	17.54	1,190	40.88	3
Honey locust	22.1	83	301.6	294.1	4.61	-2.49	52.8	17.51	1,429	840	41.22	710	50.31	4
Total			8,341.8	8,239.7			2,239.0		41,219	33,190		28,300		96
Average						-1.22		26.84			19.48		31.34	

the stem volume inside bark as determined by Smalian's formula. It appears from Table 1 that the volume of limbwood above 4.0 inches in diameter per tree is equal to approximately 27 per cent of the volume of the main stem.

In the past, board foot volume tables have usually been based on stem utilization to a fixed upper diameter limit. Utilization practice and growth habit practically preclude the successful application of this policy to the Delta hardwood species. The base of crown and presence of numerous small limbs are frequently of more importance in determining merchantable length than is a fixed top di-

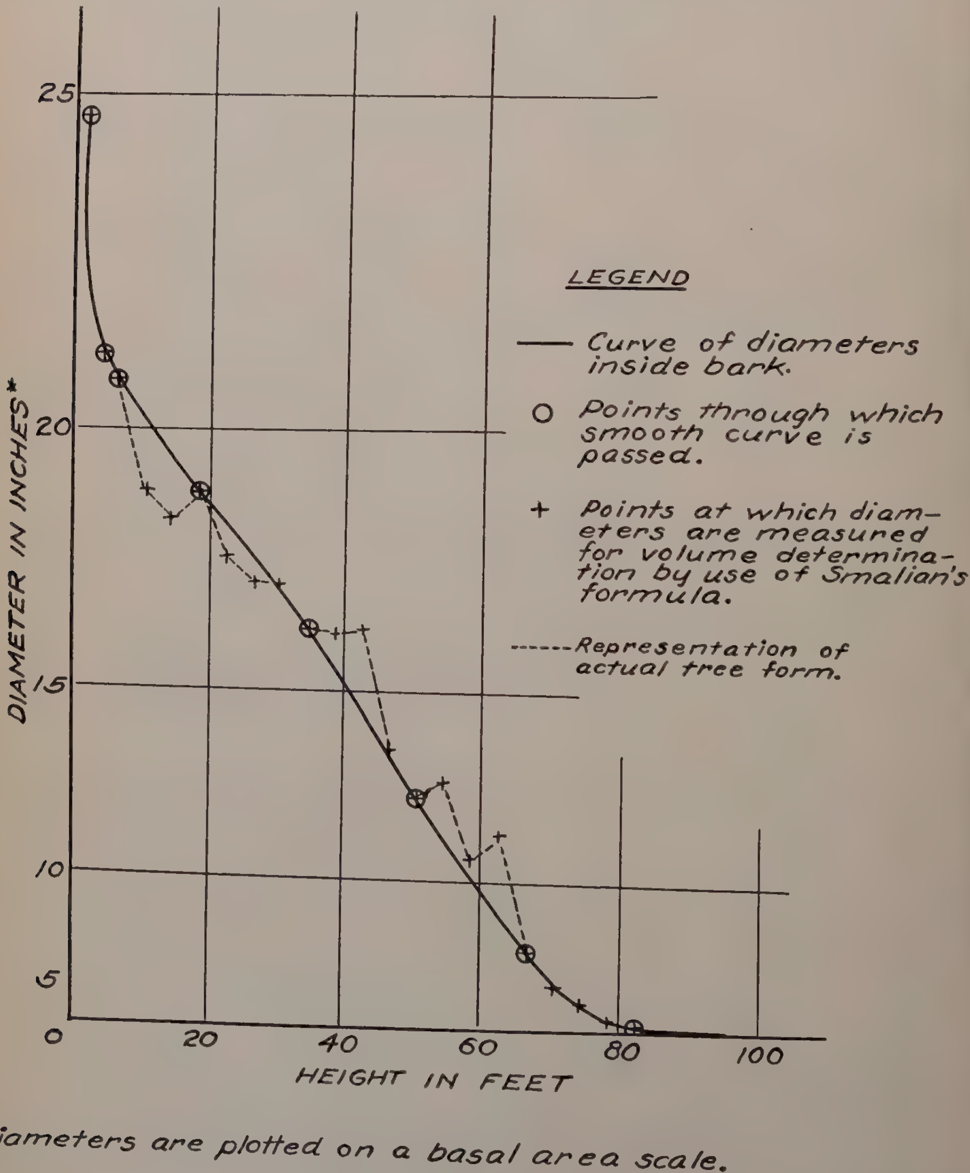

Fig. 1.—Inside-bark stem curve of a willow oak.

ameter. For this reason, the customary practice of scaling the board foot contents of individual trees to a given top diameter from the stem curve by means of a transparent overlay sheet cannot be followed rigidly. An acceptable practice would be to read the stem volume up to, but not beyond, the usable height on the tree stem. This would be different for each tree, and would of necessity be determined in the field and indicated on the field sheet.

In order to show the amount of error resulting from the use of a fixed diameter limit of 10 inches, which is approximately the smallest usable size of material for the most valuable of the Delta hardwood species, the board foot volumes by Scribner rule to a 10-inch top were read from the individual stem curves to the nearest 5 or 10 board foot unit, depending upon the scale of the overlay. Fractional logs were scaled to the nearest 2 feet of length. Volumes of fractional logs were considered to be directly proportional to the length of section. The aggregate of these volumes, determined by species, is shown in column 10, Table 1.

In column 11, Table 1 is shown the volume, to the nearest half-log, of material that can only be considered merchantable under the very closest utilization that is physically possible. Merchantability in this instance is not based on sawlog material alone, but on the assumption that all material suitable for railroad ties and stave bolts is also removed at the time of logging. Mr. J. A. Putnam of the Forest Service, who has had extensive experience in hardwood utilization in the Delta region, fixed the merchantable limit on each tree used in this study. Column 12, Table 1 shows that approximately 19.5 per cent of the board foot volume read from stem curves of Delta hardwood species cannot be considered merchantable according to best possible utilization practice. Column 14, Table 1 indicates that 31.34 per cent of this same basic volume was not utilized. This discrepancy is largely due to the fact that stave mill operators are unable to use low grade logs, and that tie cuttings were not made following a sawlog or stave operation. Furthermore, the merchantable length of many of the second growth trees was so small that units of one-half standard 16-foot logs did not accurately express the merchantable length. Frequently 2 to 6-foot lengths were left in the top.

SUMMARY

Cubic volume determination of stems of Delta hardwood species by use of

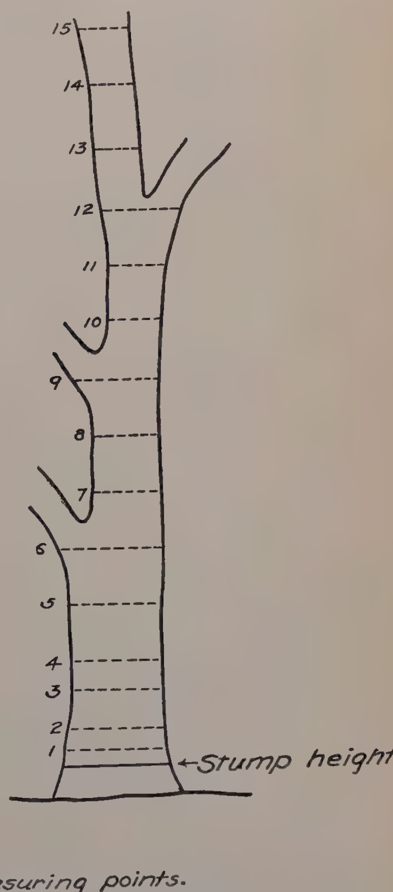

Fig 2.—Diagrammatic representation of the stem form of typical hardwood tree.

Reineke's planimeter method appears to give consistently lower volumes than the application of Smalian's formula to short stem sections. The aggregate deficiency amounts to 1.22 per cent of the Smalian volume.

The amount of limbwood present in the Delta hardwoods is equivalent to nearly 27 per cent of the main stem cubic volume inside bark obtained by use of Smalian's formula.

The difference between the board-foot volume of material merchantable according to best possible utilization standards and the board-foot volumes to a 10-inch top read from stem curves is approximately 19.5 per cent of the latter volume. The corresponding percentage figure for the material actually utilized in this study is 31.34 per cent.

Conclusion

Although the Smalian formula using 4-foot sections may determine the absolute volume of the tree stem with greater precision than the Reineke planimeter method employing 16-foot sections, it is doubtful if the cubic volume of stem irregularities is of practical significance. In all probability the planimeter method approaches more closely the effective cubic volume of the stem for utilization purposes.

The volume of merchantable material in board feet can be determined by overlays from the stem curve only if the merchantable height has been ascertained in the field, and indicated on the record sheet. Broad-foot volumes should consider only the stem lying below the merchantable height.

The volume of limbwood must be approximated by measuring the mid-diameter of 4-foot lengths and cubing them as cylinders. This procedure does not lend itself to the planimeter procedure, and constitutes a separate phase of the volume calculation.

It is therefore recommended that the Reineke planimeter method of volume determination, with the preceding modifications, be used in volume table construction for second-growth Delta hardwoods.

COMMENTS

By L. H. Reineke

California Forest Experiment Station, Berkeley, Calif.

In their comparison of the Smalian and the planimeter methods of tree-volume determination, Winters and Wheeler fail to recognize the difference in mathematical concept underlying the two methods.

The Smalian formula computes with mathematical rigor the volume of the frustum of a paraboloid. As applied to tree-volume determination, it is assumed that short sections of the stem constitute paraboloidal frusta: the accuracy of such volume determinations depends solely on the exactness with which the paraboloid frusta represent the stem sections.[1] It is common knowledge that such is not the case with the extreme tops and with the butt sections, notably so with swell-butted species such as cypress, tupelo and western red cedar. Serious errors due to these departures from paraboloidal form are

[1]Both methods embody the assumption that the field measurements of stem diameter permit the accurate determination of cross-section area. This is not strictly true when the stem is not exactly circular in cross-section. Such errors will be present in the same degree in both methods and may therefore be disregarded in the ensuing discussion.

avoided by cubing tops as cones and by applying the Smalian formula to very short sections of the butt; regardless of shortness of section some error results when this is done, though it may be reduced to negligible value.

The underlying mathematical principle of the planimeter method is that of the integral calculus. The area under the taper curve represents the volume of tree, since the ordinate represents cross-section area, the abscissa represents height (or length) and their product therefore represents volume. Were the exact equation of this curve known, the area beneath it could be computed by the methods of integral calculus. The determination of the equation and its integration by mathematics would be laborious and unjustified, especially since the planimeter integrates this area, mechanically, with a theoretical accuracy equal to that of computation methods. The actual mechanical accuracy of the planimeter is extremely high; for all practical purposes its measurements are of unquestioned accuracy when properly made. It is obvious that the volume obtained by planimeter is the true volume of the tree measured, when the taper curve accurately represents the tree.

The accuracy of representation of tree form by taper graph, or of approximation thereto by paraboloid frusta obviously depends upon the number of points at which diameter measurements are made. Extreme exactitude in determination of stem form is neither obtainable nor necessary for practical purposes. With trees of regular stem form, relatively few measurements are necessary for reasonable volumetric accuracy. Trees with irregular stems require more measurements, and for the same degree of accuracy the number of measurements required increases with the irregularity. These considerations apply with equal force to any system of stem volume computation. (It does not apply, of course, to xylometric methods.)

With any given series of measurements, Smalian-formula volume can be determined with facility by the planimeter method. All that is necessary is to plot the measurements on Form 558-a and connect the points by *straight* lines. The area under this broken-line graph exactly represents the volume given by the Smalian formula. (If the top is cubed as a cone, the last section of this graph becomes a slight curve, concave upwards.) If the usual curved taper graph is fitted to these same points the areas enclosed between the broken-line graph and the curve will represent the volume by which the Smalian formula exceeds or underscales the true volume. (Broken-line graph above curve denotes Smalian volume in excess of true volume, and vice versa.)

Referring to Fig. 1 of the article under discussion, it is apparent that the Smalian volume, computed from the same measurements (circled points) on which the taper graph is based, closely approximates the true volume except for the first and the next to last sections, for which the Smalian volume exceeds the true volume. Only minor differences between Smalian and true volume would be obtained were the taper curve fitted to all the intermediate points measured for use with Smalian formula. The resultant curve would be extremely irregular, of course, but it would be a better representation of the stem than the dotted broken-line curve shown.

This extreme irregularity is enforced by use of the Smalian formula. For efficiency in computation, it is necessary to make measurements at uniform intervals, regardless of whether the point of measurement falls on a "peak" or not. It is extremely poor practice to make measurements over local enlargements such as occur at the junction of large branches with the bole. Measuring diameters at points 5, 6, 8, 9, 11, and 12 (Fig. 2) violates this principle, but is necessary if an unjustifiable increase in labor, due

to individual computation of varied-length sections, is to be avoided.

In contrast to this enforced malpractice, the flexibility of the taper graph method permits measurement at any point desired. (Uniform-interval measurement is never necessary, as indicated in the original article presenting the method, and is often undesirable.) For the tree of Fig. 2 measurements should be taken only at points 1, 2, and 3 above 4, a little below 7, at 8 and 10, a little above 12 (just above the crotch), and at 14. The volume in the branch swelling, utilized only in cordwood, is thus rightly eliminated. This selection of point of measurement reduces the field work, gives a more representative series of points, and above all does not increase the office work of volume determination. This feature of the planimeter method is extremely valuable and should be borne in mind at all times.

As stated by Winters and Wheeler, the determination of limb volume by planimeter is not feasible. However, a ruled space on the back of the revised Form 558-a permits recording of such data. It might be suggested that such volume determinations can be simplified by adding to the calipers a scale of basal area, by which mid-section areas can be read and recorded directly. The sum of such areas, multiplied by the section length, will give the aggregate limb volume without intermediate calculation.

Aside from Reineke's comments upon the fine mathematical concepts underlying the planimeter and Smalian methods for volume determination of the exceedingly erratic stems of harwood species, his principal difference of opinion seems to be, that he would discard the wood volume contained in the swollen stem portions found at the bases of large branches. He agrees, however, that the wood volume of the branches, themselves, should form a part of the total cubic volume of the tree. For a number of hardwood species, the volume of material thus discarded would be much greater than the volume error resulting from the departure of 4-foot stem sections from the form of a frustum of a paraboloid.

Before the methods of hardwood volume research become well established, research agencies should decide whether cubic volume expresses the woody content of trees of given size or the amount of that woody content suitable for some product, lumber, for example.

R. K. W. and P. R. W.

Editor's Note: There is danger that the mensurationist becomes so filled with the mathematical theory that he fails to see the trees. Our forest mathematics has been developed mostly in the office. There is great need for efforts like the one of Winters and Wheeler to adjust the theory to the limitations of practicality.

SAMPLING DOUGLAS FIR REPRODUCTION STANDS BY THE STOCKED-QUADRAT METHOD

By R. W. COWLIN

Associate Forest Economist, Pacific Northwest Forest Experiment Station

Experiences of the Forest Survey in the Douglas fir region have proven that the four-mil-acre unit, 13.2-foot square, is a satisfactory size for the application of the stocked-quadrat method of sampling reproduction in Douglas fir stands of from 5 to 25 years of age.

THE INADEQUACY of the conventional system of gauging degree of stocking in young stands of reproduction by number of trees per acre led to the adoption of the stocked-quadrat method by the forest survey of the Douglas fir region. The fallibility of the "number of trees per acre" method is manifest, for it fails to give proper weight to distribution of the trees and consequently does not indicate accurately the proportion of the land and light being utilized by tree growth. Shortly after it was decided to use the stocked-quadrat method in the Douglas fir region, it was learned that a similar method was already in use in the Northern Rocky Mountain region. The May, 1931 issue of the JOURNAL OF FORESTRY contained an article by I. T. Haig fully explaining the theory and application of the stocked-quadrat method, particularly with reference to conditions in the Northern Rocky Mountain region. Haig's article stimulated such interest in this subject that it was thought that some experiences gained from the use of this method in the Douglas fir region might be of further interest to foresters in other regions.

The essence of this method is the division of the area under examination into squares of such a size that when unoccupied by a seedling or tree, any one square will constitute an opening in the forest that could have supported a tree from seedling to rotation maturity. The relationship between the number of occupied and unoccupied squares indicate the degree of utilization of the area by tree growth.

The success of this method depends upon the selection of the proper sized square. Theoretically, the square should vary in size with species, age, and site, but for practical application in this region it was necessary to adopt a sized square that would apply to the stands for which this system was to be used, namely, well established stands from about 5 to 25 years of age. Analysis of the factors involved indicated that the square should vary from about 10 feet to 15 feet on a side. It was finally decided to use the four-mil-acre or 13.2-foot square as being an average that would give satisfactory results on most sites and for the age classes for which this method is to be used and in addition an exact fraction of an acre (1/250) and a practical size for field use.

The next problem to be considered was the definition of the grades of stocking. The following grades of stocking were adopted as being the most logical:

Good stocking equals 70-100 per cent of the squares stocked.

Medium stocking equals 40-70 per cent of the squares stocked.

Poor stocking equals 10-40 per cent of the squares stocked.

Nonstocked equals 0-10 per cent of the squares stocked.

If each of the 250 squares in an acre were stocked, it would be possible to have

only 250 trees per acre, and yet the acre would be fully stocked according to the definition. Obviously, such a perfect distribution is highly improbable in nature, for on the contrary distribution is uneven or patchy in most instances. However, the fear existed that a square of such a size would admit areas with too few trees, particularly under the above grades of stocking. The theory was advanced that if there was one tree on the 13.2-foot square, there would be more in most cases, and in the final analysis there would be ample trees to provide for mortality and insure quality production of timber in the mature stand. To reduce this assumption to a factual basis, an analysis was made of the average number of trees per square found by actual field count in extensive areas of Douglas fir reproduction stands.

The data used were collected on a linear survey of Lewis County, Washington completed June, 1931. In this survey plots were normally taken at one-chain intervals when crossing reproduction stands on cut-over lands and old burns. The normal procedure on these plots is simple: the chain point marks the common corner of a set of four 13.2-foot squares, the examiner marks this point with his jacob staff and scrutinizes each of the four squares in turn, recording each square as stocked or non-stocked upon finding or failing to find one well-established seedling within the confines of the square. Upon the discovery of one seedling, the field man looks no longer, but proceeds to the next square. At ten-chain intervals special counts were made to furnish the data for this analysis. At these points the total number of trees in each of a set of four squares was counted and recorded. Results of the count on 718 sets of squares or 2,872 individual squares have been compiled and analyzed; of the 718 sets 456 had one or more of the four squares stocked, the remaining 262 sets of squares were entirely devoid of tree growth. This indicates that the squares did not all fall in areas of dense reproduction but were scattered through poorly stocked, medium stocked and devastated areas as well. These plots were scattered over some 284 miles of strip line, some in the foothills of the Cascade Mountain Range, some in the mountains of the Coast Range, and some in the valleys and plains between these two mountain ranges, and with this wide distribution the samples taken may be considered as being typical of the Douglas fir region.

The first step in analyzing the data was to record the number of squares with 1 tree, 2 trees, 3 trees, etc., and then the weighted average number of trees per square was computed. The number of trees per square ranged from 1 to 269 in the field, but to be conservative and to avoid giving undue weight to squares containing an excessive number of trees, all squares containing 11 or more trees were counted as having 11 trees only in the office analysis. Theoretically this method would allow not more than one tree to each 16 square feet. To make a simple test of the consistency of the results, the data were arbitrarily divided into three groups and analyzed separately and in combination. Table 1 shows the results of this analysis.

If the total number of trees had been

Table 1

AVERAGE NUMBER OF TREES PER SQUARE AND PER ACRE

	Group 1	Group 2	Group 3	Total
Total number of trees	1961	2770	1690	6421
Number of squares	377	532	307	1216
Average number of trees per square	5.2	5.2	5.5	5.3
Trees per acre	1300	1300	1375	1325

used instead of stopping the count at 11, an average of 10.5 trees per square or 2,625 trees per acre would have been obtained. Evidently then the figures in Table 1 are conservative and the slight variation in each of the three groups proves them consistent and a sufficient sample.

Using the grades of stocking defined earlier and assuming that the figure of 5.3 trees per square is a constant relationship regardless of degree of stocking, the following figures were calculated.

TABLE 2

AVERAGE NUMBER OF TREES PER ACRE BY CLASSES OF STOCKING

Grade of stocking	Percentage of squares stocked	Number of trees per acre
Good	70–100	928–1325
Medium	40– 70	530– 927
Poor	10– 40	133– 529
Nonstocked	0– 10	0– 132

The data available from the Lewis County survey were used in a different approach to the determination of the suitability of the 13.2-foot square. An analysis was made of the results obtained by using counts on squares of this size in areas previously classified to degree of stocking by ocular inspection on the part of field examiners. Theoretically the field examiner classified these areas without reference to the results being obtained by the mechanical sampling; actually the men may have been influenced by the results from the sampling of areas previously encountered and classified by inspection. However, this influence, if any, would be slight as the results of the mechanical sampling were not analyzed until the field work was completed, and the only way the mechanical sampling could bias the field examiner's judgment would be from his casual scanning of the results of the count on the squares during the day's work. A very simple method was used in this analysis; areas classified by ocular inspection in the field as poorly, medium, and well stocked were selected, and the number of stocked squares were recorded in each and the ratio of stocked to total squares was computed for each degree of stocking. The table below shows the results obtained:

If it is assumed that the areas classified as poorly stocked, medium stocked, and well stocked by the silvicultural examiner approximate the average of their respective classes (Column 3), the results in percentage obtained by using the count of the stocked quadrats (Column 6) give a very satisfactory correlation and coincide closely with the examiner's conception of the three degrees of stocking.

The satisfactory results obtained from these tests establish the soundness of the assumption made in selecting the 13.2-foot square as the most suitable unit for this particular work and also confirm our belief that the stocked-quadrat method in addition to giving a correct interpretation of actual conditions is exceedingly simple of application in the field and easy of analysis in the office.

TABLE 3

COMPARISON OF STOCKING CLASSIFICATION ON IDENTICAL AREAS BY THE STOCKED-QUADRAT METHOD AND BY OCULAR INSPECTION

By ocular inspection			By stocked-quadrats		
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
Classification by examiner	Percentage of squares stocked by definition	Medial percentage	Number of stocked squares	Total number of squares	Percentage
Poor stocking	10–40	25	159	552	28.8
Medium stocking	40–70	55	400	716	55.9
Good stocking	70–100	85	612	700	87.4

RECENT DEVELOPMENTS IN THE LUMBER INDUSTRY[1]

By WILSON COMPTON

Secretary-Manager, National Lumber Manufacturers Association, Washington, D. C.

Twenty-five years ago the public was anxious lest the timber supply be inadequate to meet its demands for forest products. Today its concern is directed toward the forest industries themselves as profitable enterprises. This transition reflects the economic problems and conditions that have been accumulating in the natural resource industries generally. The author, by training and long experience particularly competent to discuss the problems besetting the lumber industry and their amelioration, gives here a commendably frank and impartial analysis and criticism, and a suggestion for a course of constructive action which should greatly improve the economic position of the forest industries.

A QUARTER CENTURY ago the President of the United States, in a special message to Congress, transmitting the report of the National Conservation Commission, made this statement:

"If we of this generation destroy the resources from which our children would otherwise derive their livelihood, we reduce the capacity of our land to support a population, and so either degrade the standard of living or deprive the coming generations of their right to life on this continent. . . . . The great basic facts are already well known. We know that our population is now adding about one-fifth to its numbers in ten years, and that by the middle of the present century perhaps one hundred and fifty million Americans, and by its end very many millions more, must be fed and clothed from the products of our soil. With the steady growth in population and the still more rapid increase in consumption, our people will hereafter make greater and not less demands per capita upon all the natural resources for their livelihood, comfort and convenience."

A year ago the President of the United States appointed a Timber Conservation Board. In his own words, he asked it to consider the serious "problems and consequences of overproduction in the forest industries," with view to a recommendation of constructive action through "concerted programs of private and public effort."

In a recent published report of the Survey Committee of the U. S. Timber Conservation Board is a significant finding of fact:

"The industry (timber) as a whole has been substantially depleted of working capital. And the depletion is continuing. It is evident that to a substantial extent the industry's operations are being maintained not out of income, but out of conversion or liquidation of capital assets at a loss. It appears from competent testimony submitted to the Timber Conservation Board that the capital structure of the lumber industry as a whole will not, without general financial disintegration, long withstand the continuing depletion of its capital assets; and that the correction of that condition is dependent upon the establishment of a reasonable balance between lumber supply and demand."

These portions of official reports separated in time by less than a quarter of a century illustrate the striking transformation which had taken place in the economic relationships of our natural resources. Twenty-five years ago the great public concern was for the protection and perpetuation of our national resources, in forests, mines and waters. Today the great public interest is focused on the effort to conserve the industries

[1]Address delivered at Cornell University, on the Jacob Schiff Foundation, December 9, 1931.

hemselves based on the utilization of natural resources, threatened with impoverishment and disintegration as a result of chronic overproduction or overcapacity to produce. Formerly the anxiety was lest the timber supply be inadequate to meet the public demands for forest products. The direction of this anxiety has now been largely reversed. The present public concern is lest the commercial uses for forest products will be inadequate to maintain profitable forest enterprise and through it maintain the economic incentives to forest conservation. This striking transition is of much more than casual interest to the American people. It is a mighty reflector of present trends in the natural resource industries generally.

We are now witnessing on a nationwide, yes a world-wide scale, the problems and conditions which have been accumulating in the natural resource industries, and particularly in the timber industries during the past decade. These economic problems confronting the forest industries are of two distinct types:

First, those which are unique or perhaps common to the natural resource industries.

Second, the common interests of all industry and commerce.

Facts and Problems Common to Natural Resource Industries

Most modern industries are highly mechanized. Their technical complexities are almost infinite. But the interdependence and inter-action of different industries have become almost equally complex. To that extent no industry can solve its own problems independently of the measures for similar purposes taken by other industries. The lumber industry twenty years ago showed some of the symptoms of unbalanced production and consumption which since that time and in recent years have become chronic. The coal, the mining and the oil industries, favored by increasing ratios of demand and consumption, did not show the same symptoms until the last decade. Industry generally, as a result of the events of the past two years, is just becoming accustomed to the condition which had already largely fastened itself upon the natural resource industries,—a condition which points to the fact that in this age of technology and mechanized production, the decisive economic factor is not production but consumption; that prodigious production, if unbalanced and undigested, may become a national curse instead of a national blessing; and, for the time being at least, that we need much more to produce buyers than to produce goods.

Few industries are more complex than are the forest industries. Within the limits of desirable brevity I may do no more than to furnish a background of understanding which will permit intelligent interpretation of what I believe to be constructive suggestions for the remedy of our present American forest paradox: Too much lumber and not enough forests. I ask you to think of the lumber industry and of its present economic problems in the light of the changing conditions, of the last thirty years, in commerce and in industrial technology: The oldest American industry; established three centuries ago; sharing with the hardy pioneer the trail-blazing which gradually opened up the vast natural resources of the United States; proud of its rugged history and, unfortunately too complacent and too much a slave of its own traditions; the supplier of housing for more than four-fifths of the American people; the source for three centuries of the favorite and almost universally used materials of industry; encouraged by habit to depend upon custom to keep its products in use; relying on traditions when the people were breaking with traditions; depending on adherence to old styles

when the public was wanting new styles; for decades almost contemptuous of science as the work of mere theorists.

The eastern third of the United States and much of the Pacific Coast and Mountain regions were originally tree-covered. The pioneer population of America for more than two centuries found life preponderantly a battle with the forests. In our day the forests are looked upon as beneficent, and as a valuable national asset. But until less than one hundred years ago, the forests, by millions of our people, were in truth regarded as the universal menace to commercial advance and to agricultural progress. It was the forest that circumscribed and imprisoned; that held fertile lands against the plough; that made vast areas wet and swampy; that obstructed roads and made them impassable; that sheltered predatory animals; and as the breeding place of terrifying forest fires, menaced whole regions and great communities with loss of life and property. Even today the American people have not mastered the menace of forest fires which continue each year to burn over an area of forest land more than twice as great as is logged off by the great industries. For more than two centuries the national forest objective was not deliberate utilization, but destruction.

As the mining cities have come and gone with the rise and the wane of the mines, lumber towns have risen, flourished and declined with the coming and the migration of the sawmill. First, the Northeast, then the Central regions, the South, and now the Pacific West during the past century have witnessed the successive marches and migrations of the lumber industry. The frontier which was once its glory is now largely occupied by smiling farms and thriving cities, housed comfortably with its products and showing little trace and less remembrance of the lumber industry's long battle with the wilderness.

The reckless men, the legendary American lumberjacks, passionate, vigorous, impetuous daredevils who have given the picturesque color to the old-time lumber camp, are now almost a vanished race. The steadiness of a sober and methodical machine age has settled down upon the lumber and wood-using industries as they are seeking to perpetuate themselves in the forest areas of the North, the South and the West. The gaudy buckaroo, with his picturesque profanity, his goad stick and his five yoke of bellowing oxen, has been replaced by the prosaic donkey engine. The ubiquitous double-breasted, red-flannel undershirt of the old-time lumberjack has vanished. In its place has appeared even dainty rayon. So has the old rugged bunkhouse succumbed to the modern sanitary logging-camp-car village with its facilities for health and recreation, and its schools.

In the continental United States there are nearly two billion acres of land. Originally nearly one-half was in forest; today one-fourth, or about 500 million acres, is forest land. Of this nearly one-third is still in original virgin timber; one-half continues in varying degrees to bear a substantial timber growth; the remaining sixth is virtually denuded, and deprived by successive forest fires of the means of natural reforestation. Of the nation's forest lands over one-fifth is in public ownership; nearly one-third, or 150 million acres, is owned by farmers; the remaining one-half is in the ownership largely of timber, lumber and pulp and paper companies.

The average annual production of lumber in recent years has been between 30 and 35 billion board feet, equal to the combined lumber production of the rest of the world. A quarter of a century ago it was a third greater.

The use of lumber varies greatly in different regions. From about a thousand board feet per capita annually in the

North Pacific Coast states, it ranges to about 300 feet in the agricultural middle western and prairie states, and to about 200 feet in the industrial Northeast. The greatest per capita use of lumber in this country was about 25 years ago, at more than 500 feet annually. In recent years it has been about 300 feet as compared with 350 feet in Canada, 250 feet in Sweden, 140 feet in Germany, 120 feet in England, 100 feet in France and about 40 feet in Italy.

With this background the lumber industry a quarter of a century ago entered upon what has proven to have been a period of the most extensive and most vigorous competition between industries for public patronage ever recorded, a condition constantly more intensified and today more rigorous than ever. At the beginning of this century the use of lumber in this country was at its peak. For most of its important uses it had few substitutes. In many it had none. Today there is scarcely an important use for which there are not substitutes, some of them for certain purposes superior, most of them readily available, and many of them at comparable prices.

The prices of lumber at the sawmills in the principal species of softwoods and hardwoods are today about where they were a quarter century ago. In some species and items the mill prices are now the lowest of the century, and this notwithstanding the higher cost and higher value of the timber cut, the higher wage scales, the greater costs of machinery and facilities, and the higher logging costs. At the same time lumber production, due to the prevailing low demand and consumption, is now at the lowest level recorded in the last fifty years.

Of the 20 leading American industries, not including agriculture or the railroads, the lumber industry ranks second in the number of persons employed, third in the extent of its investments, and eighth in the value of its products. But in the lumber industry the annual gross value of products is only 20 per cent of the aggregate value of its investments in timber and plants. In the automobile industry, at the other extreme, the annual value of products is 50 per cent greater than the aggregate capital invested in automobile manufacture. Of the 10 largest American industries, only one shows as low a ratio of value of annual product to aggregate investment as does the lumber industry. Herein lies one of its most difficult economic problems: A relatively high percentage of fixed assets, and, in relation to annual income, a high ratio of investment in tangible property subject to increasingly heavy annual taxes, and seeking relief from multiplying capital carrying costs, through quick liquidation. This is at the foundation of the present familiar, costly and wasteful trend toward overproduction throughout the lumber industry. Supply and demand are rarely in exact balance in any industry. But overproduction in the lumber industry is not casual and transitory but fundamental and chronic. More or less the same situation prevails in the natural resource industries generally; and more or less for the same reasons.

The three most depressed of these industries, except agriculture, are coal, oil, and timber. In coal it is the huge and uncontrolled over-capacity to produce rather than overproduction itself which has done the damage. In oil it is both over-capacity and over-supply, but with a certain degree of control possible through the pipe-lines through which most of the crude oil must be marketed; and a certain amount of pace-setting leadership which is notably lacking among coal and lumber companies. I shall not undertake to analyze the condition of American agriculture as perhaps the greatest of the natural resource industries. Agricultural economics,—and, I may add, politics,—

in recent years have been minutely dissected, diagnosed, prescribed for, blundered over, and debated threadbare. The chronic impoverishment of agriculture and its basic causes are matters of universal, although disagreeable, common knowledge.

OVER-CAPACITY

It requires comparatively little capital to engage in the primary natural resource industries, more perhaps in oil and coal production, much less in lumber. At the beginning of 1930 there were, for example, nearly 15,000 small sawmills, with an average investment each of less than $5,000. They cut during the year nearly 5 billion board feet and had a combined producing capacity of nearly 16 billion. A man with a good name may today engage in lumber manufacture with less than $1,000 capital, pay for his machinery and equipment in installments; procure his timber on shares or on credit; and finance his shipments with sight drafts on the distributor through whom he sells his products.

As determined by the Census, the 1929 production of 1,167 sawmills, which cut over 5 million feet annually, was 26 billion feet, or 70 per cent of the total cut of 36 billion feet. These mills had a normal annual producing capacity of 39 billion feet. Of the sawmills operating in 1929, therefore, about 6 per cent in number could readily have produced more lumber than the total production in the United States in that year. At no time in fact, within the last decade, has the lumber production been as much as 60 per cent of the installed producing capacity. At present, for the industry as a whole, it is between 25 and 30 per cent.

LUMBER CONSUMPTION

Consumption of lumber, which a quarter of a century ago was about 500 feet per capita annually, has fallen during the past decade to about 275 feet and this year is evidently at the rate of less than 150 feet annually. This decline has been due in part to the substitution of other materials; in part to changing styles, customs and industrial and housing standards; and in large part at the moment to the fact that residential building, ordinarily the largest single source of lumber demand, is only a third of its volume of three years ago.

TIMBER SUPPLY

Present and prospective timber supply and present and prospective timber needs have been a prolific source of controversy for nearly half a century. The present generation in America has been periodically warned of imminent "timber famine" and "timber shortage." The purpose of these predictions has been almost uniformly sincere, constructive and courageous.

A quarter century ago there were repeated and dramatic forecasts of a timberless America within 30 years. Perhaps the most noteworthy result of that stream of publicity was to inspire a furious and, as it has turned out, an untimely and unwarranted speculation in western timber. Thousands upon thousands of persons financially of high and low degree bought small tracts and large tracts of timber. Much of it in isolated small holdings in the mountains of the Pacific Coast is worth less today than when it was bought. With the taxes and carrying charges, thousands of these properties represent a net and in some instances a total loss to the investor.

WHAT ARE OUR FOREST OBJECTIVES?

For what purposes do we need or do we want forests? Let me enumerate a few of them. The enumeration is neither exhaustive nor exclusive. But it is, at

least, representative and illustrative and it may afford a reasonable perspective:

1. To protect the watersheds of navigable streams, as an aid to uniformity and continuity of stream flow and to flood control.

2. To prevent or reduce soil erosion.

3. To protect wild life and provide game cover.

4. Outdoor recreation—vital to public health and general welfare.

5. Preservation of scenic beauties—important to the maintenance of spiritual as well as of economic values.

6. National defense.

7. To keep idle lands productive—a national economic objective comparable to the endeavor to avoid the abandonment of submarginal agricultural lands.

8. To provide alternative diversified employment to the American farmers—a form of so-called "farm relief."

9. To perpetuate the opportunities for profitable employment of both labor and capital and the general prosperity of large sections dependent largely on the wood-using industries.

10. To produce timber or wood for the purpose of supplying a raw material for construction and for the fabricating and wood-conversion industries — a strictly commercial objective.

I do not believe that anything but good will result from a public understanding of the great difference between adequate permanent lumber supply and adequate permanent forests. Lumber supply is only one,—although probably the most important,—of the public purposes of forests. It is readily possible to have an ample national lumber supply without having solved the important forest problems of community maintenance, employment security, productive land use, and the protective, recreational and spiritual values of forest growth. The two have been unwisely and harmfully confused.

Until the last decade the principal financial motive power in the lumber industry has been provided by appreciation in the value of standing timber. Timber history had been one of almost unbroken value increases. Timber tradition had it that values doubled each ten years. Often they did vastly more than that and great fortunes resulted. During the past decade, however, timber values have become stagnant or have declined. Timber investments are no longer carrying themselves. The vast reserve timber holdings have become a net financial burden upon the operating lumber industry. The total privately owned saw timber is equivalent to about 50 years' reserve of raw material at the average rate of timber cutting during the past few years; on the basis of present prevailing taxing systems twenty years' supply is all that the competition of other industries and of other materials will permit a well-ordered lumber manufacturing enterprise to carry. There is, accordingly, the equivalent of about 30 years' timber reserve supply now in private ownership which the lumber manufacturing enterprises cannot afford to carry; on which increasing taxes and protection charges must be paid; which is currently producing no income; and which financially cannot carry itself.

These properties, to be sure, are in ownerships of varying conditions of financial strength. There are thousands of small timber ownerships in the recesses of the western forests purchased a quarter century ago, sight unseen, by school teachers, preachers, merchants and little speculators, who have had no returns except the annual right to pay taxes and who would gladly today accept any offer of purchase. Many such small properties have in fact been abandoned for taxes. On the other hand, there are many timber ownerships well located and in strong financial possession. But, by and large, the excess timber reserves are seeking liquidation. Fifty years of timber reserves

pressing for liquidation through a manufacturing industry which cannot carry more than 20 years' reserves tells its own story.

The Government's estimate of the average value of stumpage in the United States, published five years ago, was a little over $6 a thousand feet. This represented the peak of stumpage values, in the period of 1923-25. On that basis private timber ownerships, large and small, including small farm wood-lots as well as large-industry holdings, represented an aggregate value of nearly ten billion dollars. Similarly the excess timber reserves in private ownerships represented at that time a value of over five billion dollars. Their present value is manifestly uncertain. Valid general conclusions may not be drawn from the fact that on the present market lumber manufacturers in the West are realizing nothing whatever for their stumpage, and elsewhere only a small fraction of the value of the timber in the middle of the last decade.

In the West, of course, is the principal reserve of original timber. But few western timber owners will venture today to say what timber is worth. In the South Atlantic States much of the merchantable timber is second or third, and even fourth growth,—only about 15 per cent of original timber. The average pine timber values are about $4 a thousand, as compared with $6 eight years ago, $4 immediately before the war, and about $2 in 1900. In Maine the second-growth white pine timber during the last decade due largely to competition of western woods in the Altantic Coast markets declined from about $12 a thousand feet to $3; in the Mississippi Delta hardwood timber from $8 to $5 during the last five years.

Meanwhile the carrying costs on billions of dollars' worth of timber continue relentlessly. Taxes are generally by far the heaviest factor. In recent years the lumber industry has paid in taxes a larger percentage of its income than has any other American industry except agriculture.

The importance of annual property taxation of standing timber as a factor contributing to overproduction varies greatly. No generalization is either safe or correct. Taxes on many timber properties are still moderate; on others grossly excessive. I know of some timber properties in remote locations in the West on which the annual tax is inconsequential. I may cite also at the other extreme a large operating property in the South with timber reserves sufficient to insure several years of operation on which during the past two years the taxes are equivalent to more than $10 per thousand feet of production. That is not inconsequential. As long ago as 1909 the National Conservation Commission stated:

"Present tax laws prevent reforestation of cut-over land and the perpetuation of existing forests by use. An annual tax upon the land itself, exclusive of the timber, and a tax upon the timber when cut is well adapted to actual conditions of forest investment and is practicable and certain. It is far better that forest land should pay a moderate tax permanently than that it should pay an excessive revenue temporarily and then cease to yield at all;"

and the President of the United States in transmitting its report to Congress added that:

"Second only in importance to good fire laws well enforced is the enactment of tax laws which will permit the perpetuation of existing forests by use."

With due regard to the important exceptions; it may be said that, for the forest industries as a whole, annual taxation has become the greatest single financial factor driving standing timber into premature liquidation, to meet, not the demands of the market for forest products, but the demands of the tax gatherer.

There is, of course, in the lumber in-

dustry much exaggerated individualism which prefers independence without profit to the larger promise of profit through coöperation in some effective form; which sees no benefits in coöperative programs and recognizes no group responsibility. But exaggerated individualism has failed. The lumber industry is confronted with a choice between coöperation or combination in some effective form and disintegration as a national industry. There are increasing scores of timber owners and lumber manufacturers who have a conviction of the widsom of group action, who regard it as vital to the future security and progress of the industry, but who lack the freedom of action, or the financial competence, to follow the course of action defined by sound and constructive leadership.

May I as an outsider, so to speak, on the inside of a great industry, frankly mention what appear to me to be the principal facts accountable for the industry's present ominous plight:

1. Excessive and increasing costs of carrying in private ownership great timber reserves beyond the industry's financial capacity.
2. Working capital inadequate to the dual task of financing current industry operations and meeting carrying charges on idle timber reserves.
3. Huge excess of lumber producing capacity and assumed uncontrollability of lumber production and distribution.
4. Impairment of confidence in future markets and uses for lumber, due to the extensive substitution of other materials.

From this bare recital the inference may be drawn that the conditions in the lumber industry,—and perhaps in other primary natural resource industries,—are without hope. I have in fact seen and heard what purport to be conclusive mathematical proofs that this is so. But I do not share that view. Fortunately human resourcefulness is not bound by merely mathematical limitations. The most important fact about these dismal present conditions is that none of them are necessarily incurable; and that with the aid of dependable facts, a willingness to follow competent leadership, and deliberate public coöperation, it is within the power of the industry itself greatly to improve most and perhaps all of them.

I have been frank in the analysis and criticism of the timber and other natural resource industries. But I do not wish to subject myself fairly to the imputation of either demagogy or fatalism. Criticism is constructive only when it leads to better things. May I therefore, with equal frankness, suggest a course of constructive action which in my judgment may greatly improve the economic position of the forest industries and perhaps also of other natural resource industries.

The ownership and occupancy of natural resources in forests, farm lands, mines and waters are in a peculiar sense a public trust. For a long time I have advocated the search for a solution of their economic problems through the frank approach of public and private coöperation. Such a method has a special fitness in the forest industries. Through the system of national forests the American people today are in the timber business on a colossal scale. The government is in a position to exercise a constructive and perhaps a decisive leadership in the affairs of the forest industries. Such a leadership, I believe, would be welcomed. The fear of arbitrary government domination has been largely dissipated by the common sense and the considerateness with which the United States Forest Service and other agencies of government in recent years have coöperated with the industries in the effort to establish the means of permanent, in place of migratory, timber industries and the incentives to commercial forestry as a vital means

of perpetuating the sources of their own livelihood.

The United States Timber Conservation Board, appointed by the President a year ago, is a unique agency for public and private coöperation. Its chairman is the Secretary of Commerce. It includes members of the President's cabinet, outstanding men in the forest industries, eminent conservationists and public spokesmen. With the aid of a representative Advisory Committee, under the able chairmanship of the Forester of the United States, it has been investigating the causes of the gradual and continuous impoverishment of the forest industries and their employments. Its activities have had the earnest and sincere coöperation of public and private agencies alike. It offers the hope and the promise of pointing the way to better things in forest conservation and in the forest industries.

As indicative of the present direction of its activities, it has within the last fortnight undertaken the deliberate investigation of the probable effects and the practicability of a number of proposed courses of action, which, if taken, would go a long way toward converting the American forests and forest industry situation from a liability into a national asset.

Among these proposals under study are the following:

1. The practicability of the substitution of an optional income or yield tax for the annual property tax on mature standing timber.

2. The feasibility of a permanent policy for the disposal and use of publicly owned timber with the controlling objectives: First, of maintaining timber reserves to be cut only to meet public needs; Second, to promote permanent operations on both public and private forest lands.

3. The extensive acquisition by the federal government of surplus timber reserves in the West and reforesting lands in the South and North; the probable extent of such acquisition, either by purchase, or by donation with reserved timber rights, or by exchange, necessary to establish stable conditions of forest ownership and conservative timber utilization; also the financial feasibility of such acquisition on terms under which the receipts from the sale of timber from the national forests may be expected ultimately to pay the entire cost, involving therefore no net burden upon federal revenues from taxation.

4. The probable effects and the feasibility of a system of state compacts for purposes of timber conservation and control of timber cutting.

5. The probable effects and the feasibility of federal regulation comparable in purpose to the present so-called "pure food" laws, which would require shipments of lumber in interstate commerce to be graded and identified in accordance with publicly recognized standards of grading and inspection.

6. For each of the principal forest industries periodic surveys of production, stocks and prospective consumption of their products, with recommended production quotas which, if observed, may be expected to restore a reasonable balance between supply and demand.

7. As an emergency aid to the rehabilitation of the natural resource industries through greater freedom of organized self-control, a recommendation of such action by Congress as, under the system and administration of the federal anti-trust laws and under such supervision of a competent federal agency as may be in the public interest, will apply to these industries a provision similar to those which under existing law are applicable to agriculture.

8. The continuation in some practical form of the collective means of public and private coöperation for timber con-

servation, stabilization of the forest industry and security of its employments.

This constitutes the wide range of public and private coöperation already under way. It is unique in forest and industry history. It has encountered some indifference, some prejudice and some skepticism. But these, I believe, are being gradually dissolved in favor of an obvious opportunity through sincere and earnest coöperation of public, industry, and conservation agencies to establish a forest industry situation in this country which will be an element of strength and not as now an element of weakness in our national economic fabric.

The National Lumber Manufacturers Association is the constituted national agency of the American lumber industry. With it are affiliated also many of the principal wood-using industries. It is reputed to be among the largest American industrial associations from the standpoint of the scope of its activities, the extent of its facilities, and the wide range of industries for which it speaks. It represents in ordinary times nearly one tenth of the total industrial activities of the United States. It has now, I am led to believe, to the greatest extent in its history, the confidence and support of the American timber, lumber, and wood-using industries, and of the distributors and users of their products. From time to time it has been honored for public services which it has been able to render. It seeks to occupy a position of intelligent, competent and fair-minded spokesmanship for the forest industries. It is therefore in a position of both private and public responsibility.

There is a general tendency to criticize business for running to the government in time of need, and a sense that business should put its own house in order. I am in sympathy with this view. The lumber industry, whose sturdy and tenacious individualism has perhaps contributed to its own present difficulties has not overnight lost its courage. It is, I believe, competent to establish effective and constructive self-control if given the opportunity and reasonable freedom of action. But to this end public coöperation is necessary in tax reform and in the acquisition of reserve standing timber which menaces the stability of forest ownership; in the determination of sound policies for the use and disposal of publicly owned forests; in the establishment and enforcement of grading standards necessary to fair competition; broader opportunity under the law for industrial self-regulation; encouragement to deliberate and intelligent forward planning of production and distribution in the forest industries and in fact in industries generally.

Beyond this the responsibility for industrial security and progress is on the industries themselves. The lumber industry, in seeking to improve and extend the uses of its products, has for some years been engaged in a nationwide program of research, promotion and publicity. Notwithstanding the severe decline in demand the lumber industry for the first time in a quarter of a century is now holding its own in competition with other materials. Recently as a modest beginning in the direction of organized wood research, it has established the first coöperative national lumber-industry-owned research laboratory in the United States. Wood, I believe, is capable of being made the most universally useful of the materials of industry. The possibilities are enormous in the diversification of the uses of forest products through improvements in manufacture, fabrication and refinement; through chemical treatments by which the desirable physical characteristics of wood may be stabilized, modified or controlled and wood products made proof against fire, decay, shrinkage and warping; through wood pulp products and wood chemical derivatives, a field of

which only the fringes have so far been touched by scientific research.

We are entering upon an Age of Cellulose. It promises an industrial battle of the giants in the next quarter of a century. The winner will likely be determined largely by the extent of success of science, and its laboratories, in mastering the mysteries of cellulose and lignin. The dramatic history of American industrial chemistry when chemists learned the secret of the "benzine ring" and industry learned how to apply it, may find in wood a twentieth century parallel. At any rate great transformations in the use of forest products are in prospect in the decades ahead. The mind and the determination of the timber and lumber industries are pointed in that direction.

Such are the present-day puzzles, perplexities and problems of a great industry. They involve complex problems of technology, economics and human understanding. By the success of their solution may well be measured not only the security of markets and uses for forest products; not only the permanent value of national wealth in standing timber; not only the economic incentives to reforestation; not only the permanent productive use of one-fourth of the land area of the United States, but—what is more important—the present and future opportunities for profitable livelihood to millions of the American people.

"Finally, however, it will be found that control and supervision of private property is an unsatisfactory, expensive, and only partially effective method of securing conservative forest management, where the necessity of maintaining a forest growth may exist and the financial margin that can be had from it is but small. Experience in the old countries has shown that, in spite of the much more perfect machinery for enforcing laws, and in spite of the much more ready disposition to submit to laws, than we are accustomed to see in this country, the attempts to control private property have been largely without the desired result. It then becomes preferable for the community to own and manage such forest areas."

Economics of Forestry, Bernhard E. Fernow. 1902.

FOREST COVER TYPES OF THE EASTERN UNITED STATES[1]

REPORT OF THE COMMITTEE[2] ON FOREST TYPES

Society of American Foresters, Washington, D. C.

IN JULY 1929 a Committee on Forest Types was appointed by President Redington of the Society of American Foresters and charged with the duty of classifying and preparing a list of the forest types in the eastern United States.[3] It was estimated that at least two years would be required to complete the project. Such has proved to be the case. The usual difficulties in the way of quick progress inherent in a committee, whose members are scattered and each occupied with his own work, have operated to prolong the task. The complexity of the forest itself and in several regions insufficient knowledge of the types at the beginning of the investigation have been additional retarding factors.

The present report sets forth the conclusions of the committee. It is recognized that as knowledge increases there will undoubtedly be need for changes—either additions, rejections or consolidations in the present list. Probably the list should be revised in ten years.

Content of Report

The report contains a discussion of the problem and the basis used in making the forest type classification. Following this is a list of the forest types classified under various headings. Detailed descriptions for all the types are appended. A list giving the botanical and common names of all tree species mentioned in the type list and descriptions has been added. An index of forest types is included. Previously recognized forest types are listed in this index and their relation to the forest types in the classification is indicated.

Need for a Uniform Type Classification

Demand for a comprehensive classification of the forest types in the eastern United States led to the appointment of this committee. Forestry is of relatively recent origin but has been rapid in expansion within the region considered. From the beginning of the movement up to the present date practically all foresters have had occasion to use forest types. Many of them have been forced to make new types. A variety of purposes which the types were to serve has governed in the recognition and naming of these types. Thus when the entire territory is reviewed we find a heterogeneous

---

[1]Presented at the 31st annual meeting of the Society of American Foresters at New Orleans, La., December 29-31, 1931.

[2]Membership of the committee: R. M. Evans, Assistant Regional Forester, Eastern District, U. S. Forest Service; R. D. Forbes, Director, Allegheny Forest Experiment Station; E. H. Frothingham, Director, Appalachian Forest Experiment Station; Joseph Kittredge, Jr., Senior Silviculturist, Lake States Forest Experiment Station; E. F. McCarthy, Professor of Silviculture, New York State College of Forestry, formerly Director, Central States Forest Experiment Station; L. J. Pessin, Associate Forest Ecologist, Southern Forest Experiment Station; J. N. Spaeth, Research Assistant Professor of Forestry, Cornell University; Lenthall Wyman, Associate Silviculturist, Southern Forest Experiment Station; R. C. Hawley, *Chairman*, Professor of Forestry, Yale University.

[3]The term "eastern United States" as interpreted by the Committee includes the eastern forests which are separated from the western forests by a broad zone of relatively treeless or desert country. The territory covered by the Committee extends in some places to the westward of the eastern forests as shown on the map of the "Forest Regions of the United States" issued by the U. S. Forest Service in 1924. The western boundary of the "eastern United States" as thus defined is a wavy north and south line extending from Canada to Mexico between the 97th and 101st degrees of longitude.

assortment of all kinds of forest types, (cover, physical, local, generalized, etc.), and much confusion and inconsistency in nomenclature. This inconsistency occurs not so much in the use of different names for the same tree as in the illogical use in the type names of generic, general, and site names and in the use of the same type name for two or more widely separated and distinct forest types.

So far as the interests of the individual within the boundaries of his own relatively restricted territory are concerned the types he now uses may be locally satisfactory. When the profession as a whole and the entire eastern United States are considered the present illogical situation as regards forest types becomes apparent and the usefulness of and necessity for a systematic classification and consistent list of forest types stands forth. Where local effort only is in operation the tendency is to create new types which could well be correlated with or included under a forest type already recognized. New type names of doubtful value have been introduced in this way.

Definition of Forest Type and Cover Type

Whenever the subject of forest types is discussed the question arises as to the definition of a forest type. The committee had to face this problem and decide exactly what the term "forest type" should mean in the classification to be issued. In 1913 there were published in the Proceedings of the Society of American Foresters a number of articles under the heading "Forest Types: Symposium."[4] The practical effect of these articles and the subsequent thinking on the part of the profession was the recognition of the cover type as the most serviceable kind of forest type for general use. Forest type is defined as follows by the Society of American Foresters:[5] "A descriptive term used to group stands of similar character as regards composition and development due to given physical and biological factors, by which they may be differentiated from other groups of stands. The term suggests repetition of the same character under similar conditions" - - - - "A cover type is a forest type now occupying the ground, no implication being conveyed as to whether it is temporary or permanent."

This definition is accepted by the Committee on Forest Types with the reservation that "composition" rather than "development" should be the primary basis for recognition of the forest types. It was felt that differences in character of "development" were subordinate to the cover itself and usually should be taken care of within a forest cover type by division into various qualities of site. For example it would logically follow that for any given forest cover type the development of the stands on the best sites would be different from those on the poorest sites.

Basis for Recognition of Forest Types

The classification of forest types here proposed is based on the *present tree cover*. Cover types are what the forester finds on the ground and must deal with. What is needed today is a classification on the basis of present forest cover. Forest cover types have a distinct ecological, silvicultural and management value and significance. This holds even in the case of cover types of temporary nature such as may start on burned-over or otherwise disturbed areas. The forest cover types of a temporary character as well as those of a climax character are dependent upon the physical and biological factors of the site. Today from the viewpoint of forest management the significance of ecological

[4]Proceedings of the Society of American Foresters, 8, 1913: 53-104.
[5]Journal of Forestry, 15, 1917: 80.

relationships particularly succession is well recognized.

Having decided upon the existing forest cover as the basis for type division, the question as to the degree of refinement in recognizing differences in composition demanded consideration. The variations in the forest complex are infinite. A balsam fir stand on the upper slopes of Mt. Washington is radically different from a stand of red gum in Louisiana. But if we traverse the country from one to the other of these forest types we may pass from one combination of forest cover to another by such gradual steps that it will frequently be difficult to decide where one forest cover type ends and another begins. In other words the possible combinations of forest composition which might be recognized as cover types are innumerable.

Sudworth[6] lists approximately 800 tree species within the eastern United States, a region containing over 375,700,000 acres[7] of forest land. Not all of these 800 tree species come directly in association with one another. So many of them do meet, that the recognition of every single composition combination is impractical. In selecting the combinations to be recognized as forest types the following principles have been used.

1. The cover type must actually be found occupying in the aggregate hundreds of thousands of acres. This does not require that the type cover any single large area in a solid stand, but rather that it be of a characteristic composition found here and there throughout a considerable range of country.

2. The cover type must be distinctive and easily separated from other cover types which most closely resemble it.

3. Within the foregoing limitations every important combination of cover must be recognized as a forest type.

No matter whether few or many types are made there will always be found areas in the field which stand as transition between the existing types. Careful judgment may be required to decide under which type the stand in question should be placed. It cannot be expected that any type list suitable for a region the size of the eastern United States will provide a name for every cover combination. Only those of distinctive character and considerable area merit recognition.

It is essential that this classification should take cognizance of the forest types now recognized in literature and practice. Only in this way can the cooperation of the profession be secured to accept and use the type classification. Many type names undesirable from the standpoint of nomenclature have been brought into use in the past. While it is desirable that these names be superseded, yet their relation to the new names has been indicated in the type descriptions and forest type index.

Provision for Expansion or Contraction

Numerous individuals and organizations with varying viewpoints make use of forest types. Undoubtedly diverse purposes and circumstances may justify, temporarily at least, different degrees of intensity in separating the forest into types. For example: A research forester, while conducting intensive experiments on small areas, may find his needs require a minute division into cover types which recognizes each small change in composition; on the other hand an administrator of a large inaccessible forest area can, in the early stages of development, usefully employ only a broad grouping which throws

[6] Check List of the Forest Trees of the United States, Their Names and Ranges by Geo. B. Sudworth. Miscellaneous Circular 92, U. S. Department of Agriculture, 1927.

[7] Report of the Forester for the fiscal year ending June 30, 1930, U. S. Department of Agriculture, p. 19.

together several important combinations of cover.

The classification presented by your committee purposely takes a middle ground between the extremes. The list is so arranged as to permit and to encourage two procedures, namely, either expansion or contraction. As an illustration of possible expansion type 18, red spruce, is often subdivided in New England and New York into spruce flat, spruce slope, and old field spruce. If a smaller number of types is wanted types 12, 13, 14 and 15 may be combined under one name. This illustrates how the list may be contracted. Some of the more logical combinations of types are indicated in the type list under the column headed "type groups."

Arrangement of the Types According to Habitat

Such combinations have been facilitated by the arrangement of the list. This has been designed so as to bring together those forest types which normally are found occupying similar habitats. In developing this idea all types are placed under one of the four great forest regions commonly recognized,[8] namely the Northern, Central Hardwood, Southern and Tropical Forests. The word "Hardwood" has been omitted since coniferous types occur and the region is designated simply as "Central." Each type appears in the list only under the Forest Region in which that type characteristically belongs.

There are many cases where types occur to a limited extent in regions other than the one in which listed. For example occasional stands of type 90, southern white cedar, can be found near Boston, Mass., in Connecticut and northern New Jersey. Although these places are either in the northern or central forest regions, this does not change the fact that southern white cedar is characteristically a southern forest type. One exception has been made in the case of type 61, cottonwood. This type is listed under the central forest and under the southern forest because it is widely distributed and at home in both regions.

As a further step in bringing together the forest types occupying similar habitats an additional grouping on the basis of soil moisture relation has been employed. Three divisions are recognized as follows:

Dry. Situations which are dry due to whatever cause whether it be light porous soil, shallow soil, steep slopes and ridges or low rainfall.

Fresh to moist. Situations with reasonably good but not excessive moisture supply.

Wet. Situations having an excessive supply of moisture, at least during a part of the year.

In all but one instance a forest type is listed only under one moisture division, namely the situation where found in greatest abundance and of most characteristic occurrence. As a matter of fact a good many types do spread to a limited extent over more than one moisture situation. Where distinctly characteristic of and abundant upon two moisture situations the type is listed on both situations but carries the same name and type number on both situations. It was necessary to do this only in the case of type 63, longleaf pine.

Within each moisture situation the types are arranged, so far as possible, so as to bring side by side the types which stand closest in nature and hence could be logically grouped if a contraction of the type list was needed. As already stated some of the possible groupings are indicated in the list.

Naming the Types

In naming the cover types the principle

[8]See map "Forest Regions of the United States" issued by the United States Forest Service. 1924.

of employing species names which would be descriptive of the composition has been followed. The type name if possible has been kept down to a single species or to a binomial. Trinomial names could not be avoided in a few cases. Generic names because of their indefiniteness have been avoided wherever possible. Exceptions to this rule were necessary in naming types 80, 85, and 86. One case in order to escape the employment of a name longer than a trinomial has required the use of a general descriptive name,—type 87, southern cypress—hardwood. Words indicative of site have not been used in the type names because site as commonly used on this continent is a subdivision of the cover type.

Judging Predominance

Species which appear in the type name form a predominant part, (fifty per cent or more), of the composition. Predominance may be judged on the basis of number of stems in the dominant and codominant classes combined. Where only one species appears in the name that species alone predominates. If more than one species is listed in the type name predominance will usually only be secured by combining the number of all species in the name. In rare cases an indicator species has been used in the type name. Where this has been done it is specifically stated in the type description. An indicator species will be characteristic and indicative of the type but may not predominate.

Species are arranged in the type name in order of numerical importance or indicator value beginning with the most important.

Sudworth's Check List Used for Common and Latin Names

Both the common and Latin names are taken from the Check List of the Forest Trees of the United States by Sudworth, 1927. A few exceptions have been made in cases where the check list common name is not generally known and accepted in the regions where the species is most important. For example Sudworth's "northern white pine" is changed to "white pine." Three species not included in Sudworth have been added, namely Nuttall's oak, *Quercus nuttallii* Palmer, post oak, *Quercus mississippiensis* (Ashe) Sargent and paper birch, *Betula cordifolia* Regel. Sudworth's Latin names are used as a matter of convenience because no other comprehensive check list covering the species of the region is readily available to foresters. The Committee recommends the revision of the Latin names as soon as a check list in harmony with the principles of the International Code as revised and adopted at London in 1930 is available. Such revision will bring the Latin names of this type list into harmony with the standardized nomenclature of the world.

Mixed Versus Pure Types

Wherever possible, as a matter of simplification, convenience and increased usefulness of the classification, the Committee avoided setting up a mixed type composed of two species for each of which a separate type already existed. The inevitable mixtures and transitions between types are relatively easy to assign to one or another type on the basis of simple predominance of one or another species. It is much less easy, however, to decide whether a given transition belongs to a pure type or to a mixed type composed of the same species in mixture with one or more other species.

For example no jack pine—Norway pine type is recognized although extensive areas in the aggregate exist composed of a mixture of jack pine and Norway pine. Creation of such a type was unnecessary since already type 1, jack pine, and type 3, Norway pine, were in use. Since these

types are defined respectively as predominantly jack pine or predominantly Norway pine the situation as regards mixtures of the two is easily cared for. All mixed stands, except the practically non-existent case of the stand having an identical number of each species, can be thrown into either type 1 or type 3.

The committee realized, however, that some two-species mixtures are much more common than pure stands of either species, and in such cases has set up a mixed type in place of two pure types. Type 7, gray birch—red maple, is an example.

In some instances there has seemed to be no choice but to recognize as types both pure stands of the species concerned and a mixture of the two; to illustrate, the Committee has set up types 38 shortleaf pine, 69 loblolly pine, and 68 loblolly pine—shortleaf pine in recognition of the fact that although hundreds of thousands of acres of old fields have seeded to pure stands of both these pines, other hundreds of thousands of acres, mostly but not entirely cut-over land never cleared for farming, have seeded to mixtures of these species.

List of the Forest Cover Types of the Eastern United States

Forest regions	Grouping by moisture relations	Type no.	Cover types	Type groups
Northern Forest	Dry	1.	Jack pine	
		2.	Jack oak	
		3.	Norway pine	
	Fresh to moist	4.	Aspen	Aspen—birch—pin cherry
		5.	Pin cherry	
		6.	Paper birch	
		7.	Gray birch—red maple	
		8.	White pine—red oak—white ash	White pine
		9.	White pine	
		10.	White pine—hemlock	
		11.	Hemlock	
		12.	Sugar maple—beech—yellow birch	Northern hardwood
		13.	Sugar maple—basswood	
		14.	Sugar maple	
		15.	Yellow birch	
		16.	Yellow birch—red spruce	Spruce—fir
		17.	Red spruce—sugar maple—beech	
		18.	Red spruce	
		19.	Red spruce—southern balsam fir	
		20.	Paper birch—red spruce—balsam fir	
		21.	White spruce—balsam fir—paper birch	
		22.	Balsam fir	
	Wet	23.	Black spruce	
		24.	Northern white cedar	
		25.	Tamarack	
		26.	Black ash—American elm—red maple	
Central Forest	Dry	27.	Mesquite	
		28.	Mountain cedar	
		29.	Shin oak	
		30.	Post oak	Post oak
		31.	Post oak—blackjack oak	
		32.	Black oak—post oak	
		33.	Scarlet oak—black oak	Scarlet oak
		34.	Southern red oak—scarlet oak	
		35.	Bear oak	Pitch pine—oak
		36.	Chestnut oak	
		37.	Pitch pine	

Forest regions	Grouping by moisture relations	Type no.	Cover types	Type groups
		38.	Shortleaf pine	Shortleaf pine—oak
		39.	Shortleaf pine—post oak	
		40.	Shortleaf pine—southern red oak—scarlet oak	
		41.	Shortleaf pine—white oak	
		42.	Shortleaf pine—Virginia pine	
		43.	Virginia pine—southern red oak	Virginia pine
		44.	Virginia pine	
		45.	Bur oak	
		46.	Eastern red cedar	
		47.	Black locust	
		48.	White pine—chestnut oak—chestnut	
	Fresh to moist	49.	White oak—black oak—red oak	White oak
		50.	White oak	
		51.	Red oak—basswood—white ash	Red oak
		52.	Red oak	
		53.	Yellow poplar	Yellow poplar
		54.	Yellow poplar—hemlock	
		55.	Yellow poplar—white oak—red oak	
		56.	Chestnut	
		57.	Beech—sugar maple	Beech
		58.	Beech	
		59.	River birch—sycamore	
		60.	Silver maple—American elm	
		61.	Cottonwood	
Southern Forest	Dry	62.	Sand pine	
		63.	Longleaf pine	
		64.	Longleaf pine—turkey oak	
		65.	Turkey oak	
		66.	Southern red cedar	
		67.	Live oak—cabbage palmetto	
	Fresh to moist	68.	Loblolly pine—shortleaf pine	Loblolly pine
		69.	Loblolly pine	
		70.	Loblolly pine—southern red oak	
		71.	Loblolly pine—white oak	
		72.	Loblolly pine—slash pine	
		63.	Longleaf pine	
		73.	Longleaf pine—slash pine	
		74.	Slash pine	
		75.	Cabbage palmetto—slash pine	
		76.	Water oak—willow oak	
		77.	Red gum—yellow poplar	
		78.	Live oak	
		79.	Beech—evergreen magnolia	
		80.	Hickory—swamp chestnut oak—white oak	Flood-plains[1]
		61.	Cottonwood	
		81.	Red gum—swamp red oak	
		82.	Red gum	
		83.	Red gum—Nuttall's oak—willow oak	
		84.	Willow oak	
		85.	Sugarberry—elm	
		86.	Oak—elm—ash	
		87.	Southern cypress—hardwood	
		88.	Willow	
		89.	Overcup oak—water hickory	
	Wet	90.	Southern white cedar	
		91.	Pond pine	
		92.	Slash pine—swamp black gum	
		93.	Pond cypress	

Forest regions	Grouping by moisture relations	Type no.	Cover types	Type groups
		94.	Southern cypress	Cypress—tupelo
		95.	Tupelo gum	
Tropical Forest	Dry	96.	Mahogany	
	Wet	97.	Mangrove	

[1]These types (with the exception of cottonwood) are based principally on investigations in the Mississippi Delta. Studies on other river systems in the south may indicate the necessity of recognizing additional types.

Type Descriptions

TYPE 1 JACK PINE

Composition: Jack pine, pure or predominating.

Associates: Norway pine, jack oak, aspens, paper birch, black spruce and white spruce.

Aspen and paper birch are usually coordinate, the others subordinate in mixtures.

Occurrence: From northern New England and New York, central Michigan, Wisconsin and Minnesota, northward at elevations from 600 to 1,800 feet.

On driest sands, usually originating from glacial outwash; also occurs on moist sands near swamps and on rocky ledges. Occurs in large and small areas usually coincident with sandy outwash plains, and in the rock outcrop region of northeastern Minnesota. Range has been increased by fires over areas occupied originally by Norway pine.

Place in succession: Pioneer on driest sites, succeeded by Norway pine or by jack oak or in northeastern Minnesota by white spruce—balsam fir—paper birch type.

Importance: Important type in area covered and as source of pulpwood in the northern Lake States and in Canada. Unimportant in New York and New England.

Variants and synonyms: Jack pine—oak, Harvey, Mich. Acad. Sci. Report (1919) 213-217; Kittredge, Jour. For. 23(1925) 890-895. Jack pine—white birch, Bergman and Stallard, Minn. Bot. Stud. 4, part 4, (1916) 333-378. Pine—hardwood, Lee, Bot. Gaz. 78, 2, (1924) 129-174.

TYPE 2 JACK OAK

Composition: Jack oak, pure or predominating in mixtures.

Associates include white oak, black oak, scarlet oak, or red oak, in varying proportions, either coordinate or subordinate. Sometimes also jack pine coordinate with jack oak.

Occurrence: Chiefly in central Michigan and central Wisconsin but extending also into southern Michigan, northern Wisconsin and east central Minnesota, at elevations from 700 to 1,600 feet.

On dry sandy soils of sand plains and gravelly morainal slopes.

Covers considerable areas on suitable soils along southern edge of the northern forest region in the Lake States; elsewhere local and spotty.

Place in succession: Probably originated as a subordinate species in Norway or jack pine stands. Now pioneer on those sites by reason of persistent sprouting after repeated fires. Succeeded by white oak—black oak—red oak type.

Importance: Covers a considerable aggregate area but unimportant commercially.

Variants and synonyms: Scrub oak, Forest Service, Instructions for making timber surveys in the National Forests, (1917); Wisc. Land

Ec. Inv., Wisc. Dept. of Agr. and Markets, Bul. 100 (1929). OAK FLAT, Sherrard, Rep't Mich. For. Com. (1902) 28-34. JACK OAK—WHITE OAK, Kittredge and Chittenden, Mich. Agr. Exp. Sta. Spec. Bul. 190 (1929).

TYPE 3 NORWAY PINE

Composition: Norway pine, pure or predominating in mixture with white, jack or pitch pines.

Among the associates jack pine is coordinate, white pine either coordinate or subordinate, and jack oak, white oak and red maple are subordinate. Paper birch, gray birch and aspens are sometimes in mixture as coordinates in young stands.

In central and southwestern New York, chestnut oak, hemlock, red oak and white pine are the common associates.

Occurrence: Ranges from Maine to Connecticut, northern Pennsylvania, southwestern New York to central Michigan, Wisconsin and Minnesota northward at elevations from sea level to 1,700 feet.

On sandy and gravelly locations or dry sandy loam soils. Often found on shallow-soiled rocky knolls and lake shores. Remains as a type only in small scattered patches.

Place in succession: Often follows jack pine. Succeeded by white pine.

Importance: Valuable timber type but now unimportant because area remaining is small. By reforestation extensive areas of this type are being created. Hence it may become of considerable commercial importance.

Variants and synonyms: NORWAY PINE — JACK PINE, Davis, Mich. Geol. Surv. Ann. Reports (1906, 1907). NORWAY — WHITE PINE, Harvey, Mich. Acad. Sci. Report (1919) 213-217.

TYPE 4 ASPEN

Composition: Aspen, largetooth aspen, and balsam poplar singly or in various combinations with each other or with other associates. Balsam poplar is not an important constituent except along streams and swamp margins in the Lake States.

Associates commonly found are paper birch and pin cherry. Most of the other species in the northern forest region occur at times as subordinates. An understory of balsam fir frequently is present. Pin cherry early disappears. All other species tend to outlive aspen.

In North Dakota bur oak, green ash, American elm, paper birch, boxelder and pin cherry are in mixture with aspen and balsam poplar.

Occurrence: Throughout the northern forest region and westward to Turtle Mts., and Devils Lake region in North Dakota.

At elevations from sea level to 4,000 feet. On all types of soil except driest sands and wettest swamps. Occurrence chiefly on burns, clear cut areas and less frequently on abandoned fields and pastures. In North Dakota confined to fresh, well drained, fertile soils and to north slopes which remain moist in dry years.

Place in succession: A pioneer type after fires; relatively short lived and is succeeded by one of the white pine, northern hardwood or spruce—fir group of types.

Importance: The most widely distributed type in the Lake States and forms most of the forest in North Dakota. Elsewhere less prominent although occupying a large aggregate area. At present of minor commercial importance.

Variants and synonyms: ASPEN — PAPER BIRCH, Mich. Land Ec. Surv.; Wisc. Land Ec. Inv., Wisc.

Dept. of Agr. Bul. 100 (1929); Chamberlain Geol. of Wisc. 2 (1877); Kittredge, Jour. For. 23 (1925) 890-895; Roth, U. S. F. Service Bul. 16 (1898); Stallard, Ecol. 10 (1929) 476-547; Whitford, Bot. Gaz. 31 (1901) 289; Zon, Bul. 1496, U. S. D. A. (1927). ASPEN—JACK PINE—WHITE BIRCH, Bergman and Stallard, Minn. Bot. Stud. 4., part 4, (1916) 333-378. HIGHLAND HARDWOODS, Conzet, Rep't to Minn. Legis. (1928). BIRCH—ASPEN, Dana, Tech. Bul. 166, U. S. D. A. (1930) 52-55; Weaver and Clements, Plant Ecology (1929) 435. BIRCH and POPLAR, N. E. S. Com., Jour. For. 16 (1922) 122-129.

TYPE 5 PIN CHERRY

Composition: Pin cherry pure or predominating.

Associates: In the North principally aspen, largetooth aspen, paper birch, red maple and red oak, either coordinate with or subordinate to the pin cherry. In the Southern Appalachians yellow birch, red spruce, southern balsam fir, mountain ash.

Occurrence: Throughout the northern forest region at elevations above 600 feet in the North, 3,000 feet in West Virginia, and 4,500 feet in North Carolina.

On well drained soils from poor to good quality.

In northern Pennsylvania covers large continuous areas, elsewhere more often in small patches.

Place in succession: Short-lived pioneer type which originates on clear cut or heavily burned areas. In the North succeeded by aspen, or by types of the northern hardwood or white pine type groups, or by the red oak—basswood—white ash type. In Southern Appalachians, succeeded by red spruce—southern balsam fir type, red spruce type, or by types of the northern hardwood group.

Importance: Of negligible commercial value even when prominent in area, because short-lived.

TYPE 6 PAPER BIRCH

Composition: Paper birch pure or predominating.

Associates include variable small proportions of aspen, largetooth aspen, balsam fir, red spruce, white pine, yellow birch, hemlock, red maple, red oak, basswood and others. Most associates are subordinate. Frequently an understory of conifers or tolerant hardwoods develops.

Occurrence: Northern and central New England, northern New York and the northern halves of the Lake States from near sea level to 3,000 feet.

Found on wide range of upland sites.

Place in succession: Pioneer on clear cut and burned areas, succeeded by some of the spruce—fir or northern hardwood group of types and sometimes by white pine.

Importance: Limited in area and in commercial importance.

Variants and synonyms: PAPER BIRCH—ASPEN, Stallard, Ecol. 10 (1929) 476-547. BIRCH—ASPEN, Dana, Tech. Bul. 166, U. S. D. A. (1930) 52-55; Weaver and Clements, Plant Ecology (1929) 435. BIRCH and POPLAR, N. E. S. Com. Jour. For. 16 (1922) 122-129.

TYPE 7 GRAY BIRCH—RED MAPLE

Composition: Gray birch and red maple predominating.

Principal associates are aspen, pin cherry, yellow and paper birch, white pine, white ash, sugar maple, red and white oak and eastern red cedar.

Occurrence: Central and southern

New England, eastern half New York, northern New Jersey and northeastern Pennsylvania. From near sea level to 2,000 feet.

Wide variety of sites from sand plains to heavy-soiled uplands. Wet margins of streams and ponds.

Place in succession: Originates on abandoned farm land and on cut-over white pine areas on lighter class of soils. Succeeded by white pine or by one of several hardwood types. Gray birch is short-lived and disappears in less than 60 years.

Importance: Covers considerable area but is of little commercial value.

Variants and synonyms: GRAY BIRCH, Dana, Tech. Bul. 166, U. S. D. A. (1930) 78-9; Spaeth, Harvard Forest, Bul. 2 (1920); N. E. S. Com. Jour. For. 16 (1922) 122-129. RED CEDAR — GRAY BIRCH, Lutz, Yale School of Forestry Bul. 22 (1928).

TYPE 8 WHITE PINE—RED OAK—WHITE ASH

Composition: White pine, red oak and white ash in mixture with red maple as chief associate. Various other associates may appear. Among the more common are: basswood, yellow birch, largetooth aspen, sugar maple, beech, paper birch, black cherry, hemlock and black birch.

Occurrence: Central New England and New York, except in mountains, at elevations from sea level to 1,500 feet.

On deep, fertile. moist, well-drained soils.

Place in succession: Often follows "old field" white pine but occurs also on land never cleared for agriculture. May be permanent in some places but in general tends toward white pine—hemlock type or northern hardwood type group.

Importance: Limited area in New York, but of high commercial value. Important commercial type in central New England, and likely to become more important as practice of silviculture develops.

Variants and synonyms: PINE—HARDWOOD, N. E. S. Com. Jour. For. 20 (1922) 122-129; Cline and Lockard, Bul. 8 Harvard Forest (1925).

TYPE 9 WHITE PINE

Composition: White pine pure or predominant. Pure stands of white pine are characteristic.

Associates: In the North on light soils Norway pine, pitch pine, gray birch, aspen, red maple, pin cherry and white oak. On heavier soils paper birch, black birch, yellow birch, gray birch, black cherry, white ash, red oak, sugar maple, basswood, hemlock and red spruce.

In the Southern Appalachians on moist sites yellow poplar, chestnut, hemlock, red oak and white oak. On drier sites chestnut oak, scarlet oak, shortleaf pine and pitch pine.

Occurrence: Most commonly within southern and lower portions of the northern forest from southwestern Maine to east central Minnesota and along Appalachian Mountains to northern Georgia. Most abundant in central New England and in the Lake George and Lake Champlain section of New York at elevations from sea level to 2,500.

In the Southern Appalachians of West Virginia, Virginia, Tennessee, North Carolina, and north Georgia, generally at elevations of from 1,500 to 4,000 feet, but occasionally as high as 4,700 feet. Formerly best developed in Tennessee and North Carolina between 3,000 and 4,000 feet.

In the Lake States chiefly in central part of Michigan and in north cen-

tral Wisconsin and in north and east central Minnesota; less common northward. Elevations from 700 to 1,700 feet.

Typical on fresh, sandy loam upland but occurring occasionally on clay, in swampy areas, and on loamy sands. In the Northeast occurs on abandoned agricultural land of all soil types. In the Southern Appalachians on mountain slopes, flats and valleys varying widely in soil character from sandy to clayey loam and from relatively moist to dry.

Extensive areas occupied in the Northeast, elsewhere in small stands widely scattered.

Place in succession: Frequently first type to occupy agricultural land after abandonment. Approaches permanence on sandy soils. On heavier soils usually succeeded by sugar maple—beech—yellow birch, red oak — basswood — white ash, white pine—red oak—white ash, white pine—hemlock, sugar maple—basswood, white oak or white spruce—balsam fir—paper birch.

A long-lived temporary type seldom succeeding itself except after fires or under special cultural treatment.

Importance: Important commercial type in New England and Essex, Warren and Saratoga counties, New York; about 100,000 acres scattered through Pennsylvania. Elsewhere because of relatively small area covered, not of primary importance.

Variants and synonyms: WHITE PINE—NORWAY PINE, Bergman and Stallard, Minn. Bot. Stud. 4, part 4, (1916) 333-378; Buhler, Minn. State Forester 3rd. Ann. Rept. (1913) 120-135; Roth, U. S. F. S. Bul. 16 (1898). PINE — SPRUCE Stallard, Ecol. 10 (1929) 476-547 WHITE PINE—BALSAM—HEMLOCK Whitford, Bot. Gaz. 31 (1901) 289

TYPE 10 WHITE PINE—HEMLOCK

Composition: White pine and hemlock only or predominant in mixture.

Associates are numerous but none particularly characteristic. Principal associates: beech, sugar maple, basswood, red maple, yellow birch, black cherry, white ash, paper birch, black birch, red oak, white oak, chestnut oak. yellow poplar, cucumber magnolia and red spruce.

Occurrence: Central and southern New England, New York, northeastern Ohio, northern New Jersey, central and northeastern Pennsylvania, thence on mountains to North Carolina and Tennessee. From sea level to 1,500 feet in New England and to 3,000 feet in Pennsylvania. From 1,000 to 4,000 feet in Tennessee and North Carolina.

On wide range of site from sand plains to heavy upland soils. Favors cool locations, ravines and north slopes in the southern portion of its range.

Occurs in small bodies, much scattered but not rare.

Place in succession: Near climax, probably succeeded ultimately by northern hardwoods or hemlock. Occasionally the result of long continued grazing of woodlot containing scattered pine and hemlock in mixture with hardwoods.

Importance: Not important in area and therefore not commercially important. Its value per acre often is high due to extra fine quality of pine when grown with hemlock.

Variants and synonyms: PINE—HEMLOCK, Dana, Tech. Bul. 166, U. S. Dept. Agr. (1930) 93-94; Weaver and Clements, Plant Ecology (1929) 440-2; Tarbox and Reed, Harvard Forest Bul. 7 (1924) 17-18; Marshall, Harvard Forest Bul. 11 (1927) 9-17. PINE—HARDWOOD and HEMLOCK, Fisher Harvard

Forest Bul. 1 (1921) 23-26. SUGAR MAPLE — BEECH — BIRCH — WHITE PINE — HEMLOCK, Jennings, Proc. Penna. Acad. Sci. 1 (1927).

TYPE 11 HEMLOCK

Composition: Hemlock pure or predominant over any single associate.

Associates: beech, sugar maple, yellow birch, basswood, red maple, black cherry, white ash, balsam fir, red spruce, white pine, paper birch, black birch, red oak and white oak.

Occurrence: Throughout the northern forest except in Minnesota. Elevations from sea level to 5,000 feet. In Southern Appalachians in pure stands in coves from 1,500 to 5,000 feet elevations.

From central Pennsylvania southward mostly in cool locations, moist ravines, north slopes. Somewhat drier and warmer locations at northern part of its range. Mixed with hardwoods occupies large aggregate area in northern Wisconsin and Michigan usually much intermingled with the sugar maple — beech — yellow birch type. Elsewhere in small bodies, widely scattered.

Place in succession: Probably climax

Importance: Formerly an extensive type, especially in northern Pennsylvania; still important in area and value for sawtimber and pulpwood in virgin forest in Michigan and Wisconsin. Not now so important elsewhere either in area or commercially.

Variants and synonyms: HARDWOOD-HEMLOCK, Roth, U. S. F. S. Bul. 16 (1898). MAPLE—HEMLOCK, Kittredge, Jour. For. 23 (1925) 890-895. BEECH — MAPLE — HEMLOCK, Waterman, Bot. Gaz. 74 (1922) 1-31. HEMLOCK — BALSAM — WHITE SPRUCE, Davis, Geol. Surv. of Mich. Ann. Rept. (1906, 1907). HEMLOCK — WHITE OAK, — noted on Shenandoah National Forest, unpublished manuscript, U. S. F. Service. HEMLOCK—HARDWOOD, Lutz, Yale School of Forestry Bul. 22 (1928). HEMLOCK—BIRCH, Ashe, Jour. Elisha Mitchell Sci. Soc. 37 (1922) 194, HEMLOCK—YELLOW BIRCH, S. A. S. Com. Jour. For. 24 (1926) 676. COVE HEMLOCK, S. A. S. Com., Jour For. 24 (1926) 678.

TYPE 12 SUGAR MAPLE—BEECH—YELLOW BIRCH

Composition: Sugar maple, beech, yellow birch in different proportions sometimes with smaller and varying admixtures of basswood, red maple. hemlock, red oak, white ash, white pine, balsam fir, black cherry, paper birch, black birch, American elm, and red spruce. In the Southern Appalachians Ohio buckeye, chestnut and cucumber magnolia (also in Penn.) occur. Beech does not occur west of eastern Wisconsin and adjacent Michigan.

Occurrence: Throughout the northern forest except in Minnesota. In northern New England and New York goes up to 3,500 feet; in the Lake States to 1,600 feet and in the Southern Appalachians occurs in a zone from 3,500 to 5,500 feet elevation.

On loamy soils of excellent fertility and good moisture conditions.

Covers extensive areas, except where the forest is broken by settlement and in southern Pennsylvania and in Southern Appalachians where distribution is spotty.

Place in succession: A climax type. As the type approaches the climax sugar maple, beech and hemlock assume increasing importance.

Importance: The most extensive commercial sawtimber type remaining in the northern forest.

Variants and synonyms: MAPLE — BEECH, Weaver and Clements,

Plant Ecology (1929) 453; Chamberlin, Geology of Wisconsin 2 (1877) 176; Harvey, Mich. Acad. of Sci. Rept. (1919) 213-217; Veatch, Mich. Agr. Exp. Sta. Quart. Bul. 10 (1928) 116-126. A frequent variant in southern Michigan and southeastern Wisconsin. HARDWOOD—CONIFER, Wisc. Land Ec. Inv., Wisc. Dept. of Agri. & Markets Bul. 100 (1929); Chamberlain (loc. cit.); Veatch (loc. cit.). BIRCH—BEECH—MAPLE, U. S. F. Service, Instructions for making Timber Surveys in the National Forest (1917). HARDWOOD with BASSWOOD, Wisc. Land Ec. Inv., (loc. cit.). HARDWOOD and WHITE PINE, Davis, Mich. Geol. Surv. Ann. Rept. (1906). MAPLE—BEECH—HEMLOCK—YELLOW BIRCH, Whitford, Bot. Gaz. 31 (1901) 289. NORTHERN HARDWOODS, Frothingham, Bul. 285, U. S. Dept. Agri. (1915); Dana, Tech. Bul. 166, U. S. Dept. Agri. (1930) 45-52; Zon, Tech. Bul. 1,496, U. S. Dept. Agr. (1927) 6-7. BEECH—BIRCH—MAPLE, Illick and Frontz, Bul. 46, Penn. Dept. Forests and Waters (1928). HARD MAPLE—YELLOW BIRCH, McIntire, Papers Mich. Acad. Sci. 14 (1931). YELLOW BUCKEYE — SUGAR MAPLE — YELLOW BIRCH, Ashe, Jour. Elisha Mitchell Sci. Soc. 37 (1922) 193.

TYPE 13 SUGAR MAPLE—BASSWOOD

Composition: Sugar maple and basswood predominating in different proportions.

Associates: either coordinate or subordinate, include American elm, green ash, yellow birch, white pine, red oak and rarely hackberry. Hop-hornbeam and blue beech are subordinates.

Occurrence: East central and north central Minnesota, west of the range of hemlock and beech at elevations from 600 to 1,600 feet, and intermingled with the sugar maple — beech—yellow birch type in Michigan and Wisconsin.

Rich upland loamy soils.

Occurrence spotty and in small areas. Often on lake shores.

Place in succession: A climax type.

Importance: Of minor commercial importance because limited in area.

Variants and synonyms: BASSWOOD—MAPLE, Buhler. Minn. State Forester, 3rd. Ann. Rept. (1913) 120-135. MIXED HARDWOODS, Lee, Bot. Gaz. 78 (1924) 129-174. MAPLE—WHITE PINE, Lee, (loc. cit.). ELM—BASSWOOD — HACKBERRY, Stallard, Ecol. 10 (1929) 476-547. SUGAR MAPLE—BASSWOOD—ELM, Pammel, Proc. Davenport Acad. Sci. 10 (1905) 32-126. HARD MAPLE—ELM — BASSWOOD — YELLOW BIRCH, McIntire, Papers Mich. Acad. Sci. 14 (1931).

TYPE 14 SUGAR MAPLE

Composition: Sugar maple pure.

A small proportion of other species may be present, such as yellow birch, black birch, white ash, red and white oaks.

Occurrence: Throughout the northern forest. In the Southern Appalachians at elevations of 3,000 to 4,500 feet. Elsewhere at lower elevations. Through northern Ohio found chiefly as pastured woods. Created artificially through desire to develop stand for sugar production.

On deep, fertile well-drained soils with good moisture.

Found in small patches usually not over 5 to 10 acres in size.

Place in succession: A climax type. In places may owe its origin to cultural practices.

Importance: Aggregate area limited, but type is commercially important where it occurs.

TYPE 15 YELLOW BIRCH

Composition: Yellow birch pure. There may be a small mixture of other species: in the North particularly red and sugar maples and paper birch and in the Southern Appalachians principally yellow buckeye, beech and hemlock with no paper birch and little sugar maple.

Occurrence: Northern New England, Pennsylvania and New York at elevations of 600 to 2,500 feet. Also in Southern Appalachian Mountains, mostly at altitudes between 4,500 and 6,000 feet.

On moist sites following clear cutting or other opening up of the forest.

Found in small patches.

Place in succession: Apparently a long-lived temporary type, followed by sugar maple — beech — yellow birch or yellow birch—red spruce.

Importance: Aggregate area limited, of minor importance.

Variants and synonyms: HEMLOCK—YELLOW BIRCH, S. A. S. Com., Jour. For. 24 (1926) 676

TYPE 16 YELLOW BIRCH—RED SPRUCE

Composition: Yellow birch and red spruce predominating.

Associates: In the North balsam, red maple, paper birch, northern white cedar and occasionally white spruce; in the Southern Appalachians southern balsam fir, yellow buckeye, beech, sugar maple and mountain-ash.

Occurrence: Northern New England and New York at low elevations on lower slopes and moist well-drained flats. In the Southern Appalachians at elevations of 3,500 to 5,000 feet.

Place in succession: Possibly climax on moist flats in North.

Importance: Most important type commercially and in area in northern Maine.

Variants and synonyms: YELLOW BIRCH sub-type, N. E. S. Com., Jour. For. 20 (1922) 128.

TYPE 17 RED SPRUCE—SUGAR MAPLE—BEECH

Composition: Red spruce, sugar maple and beech predominate. Hemlock is often present.

Occurrence: Northern New England and the mountainous portions of New York.

Found on deep, well-drained, fertile soils of lower slopes, benches and ridges.

Place in succession: Probably a climax.

Importance: A type of great commercial importance. Covers a large area.

Variants and synonyms: SPRUCE and HARDWOODS, N. E. S. Com., Jour For. 20 (1922) 128; Dana, Tech. Bull. 166, U. S. D. A. (1930) 29-39.

TYPE 18 RED SPRUCE

Composition: Red spruce pure or predominating.

Associates: balsam fir, paper birch, yellow birch, sugar maple, beech, red maple, hemlock, white ash, mountain-ash. In the Southern Appalachians southern balsam fir and yellow buckeye are added.

Occurrence: Northern New England, mountainous areas of New York, Pennsylvania and Southern Appalachians.

Elevations from near sea level in eastern Maine and 1,500 feet in New York to 4,500 feet; above 3,200 feet in West Virginia and above 4,500 in North Carolina and Tennessee.

Moderately well drained to poorly drained flats but not true swamps, well-drained slopes though not on the best soils, thin-soiled upper slopes. On a wide variety of soils on abandoned fields and pastures.

In New England and New York occupies large areas of flat land and in zones at higher elevations on the mountains. Less abundant in Southern Appalachians.

Place in succession: Probably near climax on moist flats and on thin soiled sites at high elevations, in other locations tending to be re-

placed by such species as sugar maple and beech.

Importance: Important in area and the most important type commercially in New England and New York. Of minor importance in the Southern Appalachians.

Variants and synonyms: In New York and New England three variants within the red spruce type are generally recognized, as follows: SPRUCE FLAT, SPRUCE SLOPE and OLD FIELD SPRUCE. See N. E. S. Com., Jour. For. 20 (1922) 125-126; Dana, Tech Bul. 166, U. S. D. A. (1930) 29-44.

In West Virginia SPRUCE—HEMLOCK is a characteristic variant.

TYPE 19 RED SPRUCE—SOUTHERN BALSAM FIR

Composition: Red spruce and southern balsam fir pure or predominating, associated in the lower altitudinal portions of the type with hemlock, yellow birch, and less frequently with beech, sugar maple, yellow buckeye, mountain-ash and hawthorn.

Occurrence: At elevations of over 4,500 feet in Southern Appalachian Mountains and over 3,200 feet in Allegheny Highlands of West Virginia on all exposures.

Place in succession: Climax. Replaced after cutting and fire by yellow birch except at highest altitudes.

Importance: Limited in area but wherever found of high importance commercially and as a protection forest.

Variants and synonyms: SPRUCE—FIR, S. A. S. Com., Jour. For. 24 (1926) 675-676.

TYPE 20 PAPER BIRCH—RED SPRUCE—BALSAM FIR

Composition: Paper birch, red spruce and balsam fir predominant. Aspen, red maple, yellow birch, white pine and northern white cedar occur as scattered individuals.

Occurrence: Found extensively in Maine and less frequently in northern New Hampshire and Vermont.

Wide range of upland soils. Distribution determined more by treatment than by site.

Place in succession: Originates on burns in the red spruce types or may succeed the paper birch type. In initial stages aspen is commonly present but owing to its short life is eliminated from the stand. Succeeded by the red spruce type.

Importance: Of considerable commercial importance in Maine.

TYPE 21 WHITE SPRUCE — BALSAM FIR — PAPER BIRCH

Composition: Mixtures of the three species in which white spruce and balsam fir are the key species although they may not always predominate.

Jack pine, aspen and black spruce may also occur in the mixture and less commonly, white pine, northern white cedar, sugar maple, green ash and yellow birch.

Occurrence: Northern Minnesota and locally in northern Michigan and Wisconsin at elevations from 1,000 to 1,700 feet on upland loamy soils.

Only small local areas of typical development remain, chiefly in the inaccessible rock outcrop region of northeastern Minnesota.

Place in succession: A climax type, along its southern border giving way to the sugar maple—basswood climax.

Importance: The mature type has a high value commercially, but occupies only a small area.

Variants and synonyms: SPRUCE—BALSAM, Mich. Land Ec. Surv.; Gates, Mich. Acad. Sci. 14th Rept. (1912)

46-103. WHITE SPRUCE U. S. F. Service (1917). BALSAM—SPRUCE, Lee, Bot. Gaz. 78 (1924) 129-174. PAPER BIRCH — BALSAM — SPRUCE, Lee, (loc. cit.) BALSAM—SPRUCE—PAPER BIRCH—ASH, Stallard, Ecol. 10 (1929) 476-547. FIR — WHITE BIRCH — YELLOW BIRCH — WHITE SPRUCE—CEDAR, Bergman and Stallard, Minn. Bot. Stud. 4, pt. 4, (1916) 333-378.

TYPE 22 BALSAM FIR

Composition: Balsam fir often pure. Chief associates: on upland sites red spruce, yellow birch, paper birch, beech, red maple, hemlock; in swamps black spruce, tamarack, red maple, black ash and northern white cedar.

Occurrence: Northern New England and mountainous areas of eastern New York. Occurs on low lying flats usually poorly drained, in swamps and on upper slopes of high mountains above the spruce types in a zone below timberline.

Relatively spotty in occurrence although extensive areas occur particularly in zones on upper slopes.

Place in succession: Pure balsam stands are usually the results of heavy cutting or blow-downs. Tend to be succeeded by red spruce on the flats and slopes and by black spruce in the swamps. Climax in the zone below timberline.

Importance: Important for protection at high altitudes. Secondary in commercial importance and in area to the spruce types.

Variants and synonyms: Sub-divisions recognized are FIR FLAT, FIR SLOPE and FIR SWAMP, N. E. S. Com., Jour. For. 20 (1922) 124-5.

TYPE 23 BLACK SPRUCE

Composition: Black spruce, pure or mixed with a minor proportion of balsam fir, tamarack, northern white cedar, black ash, red maple and occasionally paper birch.

Occurrence: In swamps. Central Michigan, Wisconsin and Minnesota northward at elevations from 700 to 1,500 feet. Northeastern New York from 300 to 4,500 feet elevation, northern and central New England.

On acid peat with little or no drainage. Closely confined to the peat swamps.

Place in succession: A subclimax type.

Importance: Covers a large area and is important commercially in the Lake States. Elsewhere of relatively small area, although often giving a heavy yield per acre of pulpwood.

Variants and synonyms: SPRUCE SWAMP (or BOG) type, N. E. S. Com., Jour. For. 20 (1922) 126; Dana, Tech. Bul. 166. U. S. D. A. (1930) 29.

TYPE 24 NORTHERN WHITE CEDAR

Composition: Northern white cedar pure or predominating.

Associates are usually not subordinate. They include tamarack, balsam fir, yellow birch, paper birch, black ash, red maple, black spruce, white pine and hemlock. Sometimes has an undergrowth of alder.

Occurrence: Northern halves of Michigan, Wisconsin and Minnesota at elevations from 700 to 1,500 feet, New York from 300 to 3,500 feet, northern and central New England.

On sites with slow drainage and high water table, not strongly acid, also on limestone upland.

Common in suitable swamps but more abundant in the limestone areas of eastern Wisconsin and Michigan. Spotty distribution throughout its eastern range.

Place in succession: If undisturbed, maintains itself as long as the swamp remains wet.

Importance: Important both commercially and in area covered in the

Lake States. Elsewhere relatively small in area but commercially important wherever found.

Variants and synonyms: CEDAR — TAMARACK—SPRUCE, Roth, U. S. F. Service Bul. 16 (1898). CEDAR — TAMARACK — SPRUCE — BALSAM, Mich. Land Ec. Surv. CEDAR — SPRUCE — BALSAM — WHITE PINE, Veatch, Mich. Agr. Exp. Sta., Quart. Bul. 10 (1928) 116-126. BALSAM—CEDAR—TAMARACK—SPRUCE, Stallard, Ecol. 10 (1929) 476-547. CEDAR — PAPER BIRCH — BALSAM — RED MAPLE, Waterman, Bot. Gaz. 74 (1922) 1-31. MIXED SWAMP, Stewart, Jour. For. 23 (1925) 171.

TYPE 25 TAMARACK

Composition: Tamarack pure or predominating.

Common associates either black spruce or northern white cedar or less commonly both. Other associates, mostly subordinate, include red maple, black ash and aspen.

Occurrence: Chiefly found throughout Michigan, Wisconsin and all except southwestern Minnesota at elevations from 700 to 1,500 feet. Elsewhere in the northern forest a rare type.

Pure tamarack occurs south of the range of black spruce and northern white cedar in the southern part of the Lake States.

Peat swamps with little or no natural drainage.

Place in succession: Succeeded by black spruce on undrained acid peat or by northern white cedar type in better drained less acid swamps.

Importance: Covers a large aggregate area in the Lake States but has little commercial importance now, because of the destruction of all merchantable tamarack by the sawfly.

Variants and synonyms: TAMARACK—SPRUCE, U. S. F. Service; Bergman and Stallard, Minn. Bot. Stud. 4 (1916) 333-378; Whitford, Bot. Gaz. 31 (1901) 289. TAMARACK — CEDAR, Lee, Bot. Gaz. 78 (1924) 129-174. TAMARACK — CEDAR — SPRUCE, Roth, U. S. F. Service, Bul. 16. (1898). TAMARACK — BLACK SPRUCE — CEDAR, Waterman, Bot. Gaz. 74 (1922) 1-31. TAMARACK—ASPEN, Stallard, Ecol. 10 (1929) 476-547. TAMARACK—ASPEN—RED MAPLE, Veatch, Mich. Agr. Exp. Sta., Quart. Bul. 10 (1928) 116-126. MIXED SWAMP, Stewart, Jour. For. 23 (1925) 171.

TYPE 26 BLACK ASH — AMERICAN ELM — RED MAPLE

Composition: The three type species occur in different proportions but together predominate over any other species which occur in mixture. Black ash occurs least often in other types and therefore may be considered an indicator species for this type. Black ash is rarely as abundant as the other two species except in the Lake States. In New England red maple predominates and may often be pure.

Associates include:—in the Lake States balsam poplar, balsam fir, yellow birch and less commonly, white pine, tamarack, northern white cedar, basswood, bur oak and swamp white oak, the latter only in the southern part of the region; in northern Ohio and Indiana silver maple, swamp white oak, sycamore, pin oak, black gum and cottonwood; in New England yellow birch, black gum, sycamore and toward the north tamarack and black spruce; in New York white ash, slippery and rock elms, yellow birch, black gum, sycamore, hemlock, bur oak, swamp white oak and silver maple.

Occurrence: Throughout the Lake States, northeastern Indiana, northern Ohio, Pennsylvania and north-

ern New Jersey, New York and New England.

Occupies moist to wet muck or shallow peat soils, in swamps, gullies and small depressions of slow drainage or in elongated areas along small sluggish streams, occasionally covering extensive swamps.

Place in succession: Climax for the site.

Importance: A minor type in area and unimportant commercially.

Variants and synonyms: BLACK ASH—MAPLE—ELM, Wisc. Land Ec. Inv. Dept. of Agr. and Markets Bul. 100 (1929); Kittredge, Jour. For. 23 (1925) 890-895. ELM—SOFT MAPLE—ASH, Veatch. Mich. Agr. Exp. Sta. Quart. Bul. 10 (1928) 116-126. ELM—BLACK ASH, Davis, Rept. Mich. Geol. Surv. (1906). BLACK ASH, Chamberlain, Geol. of Wisc. 2 (1877) 176. ELM—BALSAM POPLAR—BLACK ASH, Mich. Land Ec. Surv. Rept. (1924). ELM—ASH—BASSWOOD—RED MAPLE, Veatch, Mich. Agr. Exp. Sta. Quart. Bul. 10 (1928) 116-126. MIXED SWAMP, Zon, Bul. 1496 U. S. D. A. (1927). HARDWOOD SWAMP, N. E. S. Com., Jour. For. 20 (1922) 127.

TYPE 27 MESQUITE

Composition: Mesquite characteristically pure.

Occurrence: Central Texas and local in central western Oklahoma. On dry sites, principally flat prairies with fine compact soils.

Place in succession: Doubtful. Has taken possession of open prairie lands.

Importance: Large in area, but of minor commercial importance.

TYPE 28 MOUNTAIN CEDAR

Composition: Mountain cedar pure or predominating.

Associates: live oak, cedar elm, hackberry, Schneck red oak and shin oak.

Occurrence: Central Texas on dry, low limestone hills.

Place in succession: Aggressive in stocking open lands. After cutting and fires may succeed itself or be followed by Schneck red oak.

Importance: Chief commercial type in region of its occurrence.

Variants and synonyms: CEDAR BRAKE, Bray, Bul. 49, Bur. of For., U. S. D. Agri. (1904); Foster et al, Bul. 3, A. & M. Coll. Texas (1917).

TYPE 29 SHIN OAK

Composition: Shin oak pure or predominating.

Associates: in Texas live oak, Schneck red oak, hackberry, wild plum and holly; in Oklahoma principally in pure stands, occasionally live oak. Schneck red oak, hackberry and wild plum are found.

Occurrence: Edwards Plateau in Texas on dry, limestone areas; Oklahoma in extreme western part of the main body of the state and occasionally in islands throughout central part.

Place in succession: Unknown.

Importance: Valuable as a protector of watersheds.

Variants and synonyms: OAK SHINNERIES, Bray, Bul. 49 Bur. of For., U. S. D. Agri. (1904) 17-18. MOUNTAIN OAK, Bray, Bul. 49, Bur. of For., U. S. D. Agri. (1904) 18.

TYPE 30 POST OAK

Composition: Post oak pure or predominating.

Associates: blackjack oak, black oak, southern red oak, white oak, scarlet oak, shingle oak, hickories, shortleaf pine, Virginia pine and black gum. In Oklahoma Schneck red oak and chinquapin oak may be present and Virginia pine and scarlet

oak are absent. In Texas yaupon may be the chief associate.

Occurrence: Throughout the central forest. Dry flats, uplands and ridges, on heavy clay or loam soils often underlaid by rock, especially limestone, or by hardpan. At low elevations which may reach a maximum of 1,500 feet in the Southern Appalachian and Ozark mountains. Very dry sites if soil is heavy, otherwise blackjack oak predominates. Spotty distribution determined by soil types. In some places extensive areas are occupied.

Place in succession: Probably climax on some of the driest sites. In Texas is replacing open prairie following fire protection.

Importance: Products furnished are chiefly fuel, fence posts and ties. Relatively unimportant commercially today, but covers large area in the aggregate.

Variants and synonyms: A POST OAK—YAUPON type is recognized as a variant in Texas. On certain areas yaupon enters as an associate coordinate in the stand with post oak.

TYPE 31 POST OAK—BLACKJACK OAK

Composition: Post oak and blackjack oak predominate.

Associated in widely varying quantities are found shortleaf pine, black gum, black oak, scarlet oak, white oak, shingle oak, pignut hickory, mockernut hickory, sourwood, red maple, winged elm, chinquapin and eastern red cedar. In Oklahoma chinquapin oak is chief associate.

Occurrence: Very dry sites from Ohio westward into Oklahoma, where it is a common type, and east through southern part of central forest to Southern Appalachians and Piedmont Plateau.

On either heavy or light dry soils—post oak predominates on former, blackjack on latter.

Over broad areas and also in spots determined by soil aridity.

Altitudinal range 500 to 2,800 feet.

Place in succession: On very dry sites may be subclimax. Occupies shortleaf pine sites after repeated burning.

Importance: Of little commercial importance, although furnishing fuel, fence posts, mine props and ties on the Piedmont Plateau. One of the chief types in Oklahoma, elsewhere occupies small proportion of the forested area.

TYPE 32 BLACK OAK—POST OAK

Composition: Black oak and post oak forming the entire stand or predominating.

Associates: scarlet oak, white oak, blackjack oak, black gum, red maple, dogwood, winged elm and southern red oak.

Occurrence: Southcentral Illinois, Ozarks of Missouri, Arkansas and Oklahoma, sandstone formation of Kentucky and Tennessee.

Occurs on sites more moist than post oak—blackjack oak land. South slopes of Ozarks and Chester sandstone region of Kentucky and Missouri.

Place in succession: Doubtful.

Importance: Quite wide in range on dry sites at elevations of 2,000 feet and lower.

Variants and synonyms: SCRUB OAK, Telford, For. Surv. Ill. 3rd. Report (1926) 36-7.

TYPE 33 SCARLET OAK—BLACK OAK

Composition: The type is marked by the presence in the dominant stand of either scarlet or black oak, or of both, in greater numbers than any one of the associates. Scarlet oak is generally more abundant and characteristic than black oak. Scarlet

oak frequently forms small nearly pure stands, and small stands of almost pure black oak are occasionally found.

Associates: chestnut oak, white oak, hickories, pitch pine, black gum, chestnut, black locust, sourwood and dogwood.

Occurrence: Mountains and foothills of the Allegheny and Appalachian ranges, usually below 3,000 feet elevation, extending to the plateaus. Also in hill regions of Ohio, Indiana, Illinois and southward. Southeastern Missouri, but not in Arkansas. This type is likely to be found throughout the botanical ranges of the two predominant species.

Dry ridges, south or west facing slopes and flats, but often extending to moister situations probably as the result of logging or fire. If soil is too moist, white oak comes in. If soil is too thin, yellow pines take the site.

Place in succession: Probably a climax type on the dry soils, giving way to chestnut oak in places.

Importance: An important type in area, and of considerable commercial importance for ties and low grade lumber.

Variants and synonyms: Forms a considerable part of what was formerly known in Forest Service acquisition terminology, as "RIDGE" and "UPPER SLOPE." BLACK OAK—SCARLET OAK, S. A. S. Com., Jour. For. 24 (1926) 675 and 680. MOUNTAIN OAK, S. A. S. Com., Jour. For. 24 (1926) 680.

TYPE 34 SOUTHERN RED OAK—SCARLET OAK

Composition: Southern red oak and scarlet oak predominant.

Associates: black oak (chief), white oak, post oak, black gum and hickories with occasional shortleaf and Virginia pines.

Occurrence: Characteristic of dry sites on the plateaus, from Maryland and Kentucky to Georgia and Tennessee usually below 1,000 feet in altitude in the northern part of the region, 2,500 feet in the southern, but reaching somewhat greater elevations in Georgia.

Place in succession: Unknown.

Importance: Important commercially and in area covered.

Variants and synonyms: Many slight variants due to large number of associated species. Grades into SHORTLEAF PINE — SOUTHERN RED OAK — SCARLET OAK and POST OAK—BLACKJACK OAK types on dry sites. PLATEAU OAK, S. A. S. Com., Jour. For. 24 (1926) 681. BLACK OAK — SOUTHERN RED OAK— WHITE OAK —SAND HICKORY, Ashe Jour. Elisha Mitchell Sci. Soc. 37 (1922) 195.

TYPE 35 BEAR OAK

Composition: Bear oak pure or predominating.

Associates include: pitch pine, white pine, shortleaf pine (in New Jersey), chinquapin, chestnut, scarlet oak, black oak, red oak, chestnut oak, black locust, red maple, sassafras and black gum.

Occurrence: Southern New England, particularly Cape Cod region. Northern and (occasionally) southern New Jersey, northeastern, central and southern Pennsylvania, western Maryland and mountains of Virginia and West Virginia. Sea-level to 3,000 feet.

Occurs on drier sites. Prevailing type in anthracite coal fields of Pennsylvania. Elsewhere less prominent but often occupying extensive areas.

Place in succession: Temporary type following heavy cutting and repeated fires.

Importance: Economically worthless except as game cover.

Variants and synonyms: SCRUB OAK;

Dana, Tech. Bul. 166 U. S. D. A. (1930) 98.

TYPE 36 CHESTNUT OAK

Composition: Chestnut oak pure or predominant.

Common associates: chestnut, scarlet oak, white oak, black oak, post oak, pitch pine, black gum and red maple. Occasional associates: white pine, red oak, shortleaf pine, Virginia pine and sourwood.

Occurrence: Southern New England. New York except Adirondack Mountains, Pennsylvania, New Jersey and southward along mountain ranges at elevations of 1,500 to 4,000 feet to Georgia and Alabama.

On rocky outcrops with thin soil. Also on sandy Coastal Plain of New Jersey. At higher elevations seeks warm aspects.

In mountains occupies narrow strips along ridges; in Coastal Plain covers wider areas.

Place in succession: Permanent in some localities. Frequently follows fire and clear cutting in types containing red oak and chestnut oak. On drier sites of the chestnut type it succeeds chestnut after death of the latter from blight.

Importance: Aggregate area considerable but generally ranks low in commercial importance.

Variants and synonyms: CHESTNUT OAK—CHESTNUT, CHESTNUT OAK—WHITE PINE—RED OAK. CHESTNUT—CHESTNUT OAK — BLACK OAK, Jennings, Proc. Penn. Acad. Sci. 1 (1927).

TYPE 37 PITCH PINE

Composition: Pitch pine pure or predominant.

Chief associates: chestnut oak and scarlet oak. Minor associates include mountain pine, black oak, black gum, chestnut.

Occurrence: Northern New England, New York, Pennsylvania and New Jersey, southward along the Appalachian and Cumberland Mountains to Georgia.

In the Appalachian region, from 2,000 to 5,000 feet elevation. In New York and New England below 1,000 feet. In Pennsylvania and New Jersey from 100 to 3,200 feet.

Ridges, dry flats and slopes. Also in New Jersey on sands of the Coastal Plain.

Irregular, but sometimes covering considerable areas. Occasionally on old fields.

Place in succession: Probably temporary, resulting from fire, in the absence of which hardwoods will gradually become predominate.

Importance: Covers a large area in the aggregate, but not as yet of high commercial importance.

Variants and synonyms: PITCH PINE — CHESTNUT OAK — SCARLET OAK. PITCH PINE—MOUNTAIN PINE, S. A. S. Com., Jour. For. 24 (1926) 680. MOUNTAIN PINE—CHESTNUT OAK—BLACK OAK, Ashe Jour. Elisha Mitchell Sci. Soc. 37. (1922) 195. BLACK PINE — CHESTNUT OAK — SPANISH OAK, Ashe, (loc. cit.).

TYPE 38 SHORTLEAF PINE

Composition: Shortleaf pine pure or predominant.

Chief associates: white oak, southern red oak and black oak and in subordinated position sometimes hickories, post oak, blackjack oak, black gum and red maple; in addition on the Piedmont Plateau and in the Appalachians Virginia pine, pitch pine and scarlet oak; in Georgia and Alabama longleaf pine may occur.

Occurrence: Throughout the Piedmont Plateau and Southern Appalachians from southern New Jersey (Coastal Plain) and Pennsylvania southward to northern Georgia and Alabama, southern Tennessee, northern Mississippi and Louisiana, Arkansas, northeastern Texas and eastern Oklahoma.

n Arkansas and Oklahoma at elevations f 300 to 2,000 feet; in Pennsylvania at bout 1,000 feet; in the Southern Appalahians below 2,400 feet, elsewhere at low levations.

n mountains on low, well-drained ridges o rocky, dry south slopes; north slopes on he better drained spur ridges. On Piedmont Plateau occupies dry uplands and ridges. Often occupies old fields and "hurricane areas."

Is widely distributed often forming extensive almost unbroken stands.

Place in succession: On certain areas considered climax but may be superseded by white and red oak in some places.

Importance: Of great importance commercially often being chief commercial type.

Variants and synonyms: ROSEMARY PINE—BLACK OAK—WHITE HICKORY, Ashe, Jour. Elisha Mitchell, Scientific Society 37 (1922) 195. ROSEMARY PINE — BLACKJACK OAK, Ashe, (loc. cit.).

TYPE 39 SHORTLEAF PINE—POST OAK

Composition: Shortleaf pine and post oak predominating.

Associates include scarlet oak, blackjack oak, black oak, white oak, Virginia pine and hickories.

Occurrence: Plateaus and foothills of Southern Appalachian region, not ascending above 2,500 feet, northeastern and northcentral Mississippi, Arkansas, northeastern Texas and east central Oklahoma.

In the mountains on low ridges, dry flats and south slopes, elsewhere on thinner and poorer soils than those occupied by shortleaf pine—white oak type.

Place in succession: Unknown.

Importance: Less important than the shortleaf pine type.

Variants and synonyms: ROSEMARY PINE—POST OAK, Ashe, Jour. Elisha Mitchell Sci. Soc. 37 (1922) 195.

TYPE 40 SHORTLEAF PINE—SOUTHERN RED OAK—SCARLET OAK

Composition: Shortleaf pine, southern red oak and scarlet oak predominating.

Common associates are black oak, white oak, post oak, black gum and hickories. Pitch pine, Virginia pine, blackjack oak and mountain pine appear in some places.

Occurrence: Characteristic of dry sites on the plateaus from Maryland to Georgia, usually below 1,000 feet in altitude in the northern part of the region and 2,500 feet in the southern part.

Place in succession: Unknown.

Importance: Important commercially and in area covered.

TYPE 41 SHORTLEAF PINE—WHITE OAK

Composition: Shortleaf pine and white oak predominate.

Associates: southern red oak, red oak, post oak, blackjack oak, black gum and hickories.

Occurrence: Throughout the central forest and northern edge of the southern forest within the range of shortleaf pine. 500 to 2,000 feet elevation in Arkansas.

Moderately deep-soiled, well-drained sites with better moisture conditions than the sites occupied by the shortleaf pine—post oak and shortleaf pine—southern red oak —scarlet oak types. Occupies the better quality soils on which shortleaf pine occurs. In Coastal Plain is found only on best soils.

Occurrence spotty as influenced by topography and soil.

Place in succession: Follows the shortleaf pine type and may be replaced by some hardwood types. Considered climax on some areas.

Importance: Fairly important commercially and in area.

TYPE 42 SHORTLEAF PINE—VIRGINIA PINE

Composition: Shortleaf pine and Virginia pine pure or predominating. Associates include: pitch pine, southern red oak, black oak, scarlet oak, white oak, post oak, black gum, blackjack oak, mountain pine (only in the mountains), chestnut oak and hickories.

Occurrence: From New Jersey to southern Indiana and southward through plateaus and foothills of Southern Appalachians to northern Georgia and northeastern Mississippi reaching altitudes of 2,500 feet at southern end of the mountains.

Occupies dry sites on southern slopes and old fields. Spotty in distribution.

Place in succession: Succeeded by shortleaf pine and oaks.

Importance: Minor as to area. Important commercially only through percentage of shortleaf pine it contains.

TYPE 43 VIRGINIA PINE—SOUTHERN RED OAK

Composition: Virginia pine and southern red oak predominant.

Associates: shortleaf pine, black oak, scarlet oak, white oak, post oak, black gum, blackjack oak and hickories; in the foothills add pitch pine, mountain pine and chestnut oak.

Occurrence: Southern Pennsylvania, plateaus and foothills of the Southern Appalachian region, rarely above 2,500 feet on dry slopes and low ridges.

Irregular occurrence, intergrading with other dry site types.

Place in succession: Unknown.

Importance: Small commercial importance.

TYPE 44 VIRGINIA PINE

Composition: Virginia pine pure or predominating.

Principal associates: shortleaf pine, chestnut, white oak, chestnut oak, red oak, black oak, red gum, red maple and black gum. Pitch pine or loblolly pine is sometimes present.

Occurrence: Widely distributed in southern Pennsylvania, New Jersey (not so abundant), the Piedmont Plateau south into Georgia and westward throughout the Appalachians, mostly below 2,000 feet elevation to eastern Kentucky and Tennessee, southeastern Ohio and southern Indiana.

Occupies dry sites.

Place in succession: A temporary type often originating on old fields. Succeeded by shortleaf pine and various hardwoods.

Importance: Limited in area but often has commercial value for pulpwood.

Variants and synonyms: VIRGINIA PINE—CHESTNUT OAK—CHESTNUT, S. A. S. Com., Jour. For. 24 (1926) 682.

TYPE 45 BUR OAK

Composition: Bur oak pure or predominating.

Common associates: in Minnesota, jack oak, red oak, white oak or black oak and sometimes basswood and American elm either as coordinate or subordinate species; in North Dakota, American elm, green ash, boxelder, basswood, hackberry, cottonwood and hop-hornbeam; in southern part of type range—American elm, bigleaf shagbark hickory, white ash, basswood, blue beech, swamp white oak, pin oak, red maple and cottonwood.

Occurrence: Throughout the central West from prairies of Ohio to Nebraska, northward to central Minnesota and Devils Lake region of North Dakota.

Found in Minnesota on dry, exposed sites of sandy plains or of loamy slopes on south and west exposures. Elsewhere on heavy soils usually black prairie loam from well-drained to fairly dry.

Local and spotty and westward in strips along upper slopes of stream bluffs.

Place in succession: Pioneer type on edge of prairies. Gradually succeeded by the jack oak or white oak—black oak—red oak types in Minnesota.

Importance: Limited in area and commercial importance. The commercial value is greater in the Turtle Mountains region of North Dakota than elsewhere.

TYPE 46 EASTERN RED CEDAR

Composition: Eastern red cedar pure or predominant.

Associates: in the Northeast gray birch, red maple, black birch and aspen; in Arkansas blackjack oak, post oak, black oak and shortleaf pine; on limestone soils black locust, blue ash, black oak, white oak and American elm.

Occurrence: Scattered throughout the central forest and occasionally in the southern forest in the interior of southern Alabama, northern and central Mississippi and eastern Texas.

Dry uplands, usually abandoned pastures or fields; never in strongly acid soils. Typical of limestone outcrops.

Place in succession: Temporary type. May be first to occupy pastures since grazing favors the type. Succeeded by various hardwood types.

Importance: Of limited area. Where merchantable stands occur they are commercially valuable.

Variants and synonyms: CEDAR BRAKE recognized in Alabama as a local type. CEDAR HAMMOCK, CEDAR GLADE: Mohr, Contr. to U. S. Nat. Herbarium 6 (1901) 81, 102. CHINQUAPIN OAK — SMALL SHAGBARK HICKORY — POST OAK — RED CEDAR, Ashe, Jour. Elisha Mitchell Sci. Soc. 37 (1922) 196. RED CEDAR — GRAY BIRCH, Lutz, Yale School of Forestry Bul. 22 (1928).

TYPE 47 BLACK LOCUST

Composition: Black locust pure or predominant.

A wide list of hardwoods and yellow pines may be in mixture with the black locust.

Occurrence: Throughout the central forest.

May occur on any well-drained soil but finds most favorable conditions on dry sites, especially on limey soils.

The species escaped from cultivation over much of its range. As a type is widely distributed but spotty in occurrence. Often occurs on old fields.

Place in succession: Temporary.

Importance: At present minor but increasing through fire and planting.

TYPE 48 WHITE PINE — CHESTNUT OAK — CHESTNUT

Composition: White pine, chestnut oak and chestnut predominating.

Yellow poplar, red oak, white oak, hemlock, hickories and many other species in the coves and on lower north exposures may occur in the mixture.

Scarlet oak, red maple, pitch pine, shortleaf pine, black gum and other dry site species are the associates on south exposures, upper slopes and ridges.

Occurrence: Southern Appalachian Mountains from West Virginia to northern Georgia, reaching area climax in southwest Virginia, eastern Tennessee, and western North Carolina, at elevations from 1,500 to 4,000 feet, but occasionally found as high as 5,000 feet in eastern Tennessee and western North Carolina.

Occupies coves, mountain slopes, high hanging valleys and flat ridge tops, varying widely in soil from moist deep loams to sandy and gravelly dry sites.

This type, in which white pine sometimes constitutes as much as 40 per cent of the stand, occurs in broad zones between which there are areas sometimes twenty miles in width where the white pine becomes an unimportant and occasional tree in the stand. Now found chiefly as second-growth or in small stands of isolated virgin timber. The largest single body left in uncut condition lies on the headwaters of the Yadkin River in Caldwell and Wilkes Counties, North Carolina.

Place in succession: Unknown.

Importance: Commercially unimportant until second-growth becomes marketable.

TYPE 49 WHITE OAK — BLACK OAK — RED OAK

Composition: White oak, black oak and red oak predominate usually with a small admixture of other species.

Associates, usually coordinate with the type oaks, include: in the Lake States jack oak, scarlet oak and bur oak, shagbark or bitternut hickory, white or green ash, sugar maple and occasionally a few black cherry, butternut or large-toothed aspen; farther south American elm, red maple, black walnut, basswood, black locust, chinquapin, beech, red gum and black gum; in southeastern Pennsylvania yellow poplar, pignut hickory, shagbark hickory, mockernut hickory, white ash, red maple, beech and black gum with understory of dogwood.

Occurrence: Through the central forest, particularly the Middle West, chiefly at elevations from 500 to 2,000 feet.

Usually on loamy well-drained soils. Also found in the Lake States on gravelly morainal slopes and in northern Mississippi and Louisiana on dry ridges.

Common upland oak type in northern part of central forest from Ohio to Iowa and in southern Pennsylvania and western New Jersey.

Place in succession: In the Lake States and Ohio drainage succeeded by types in which sugar maple is more prominent.

Importance: Relatively limited in area and in commercial importance except as a large element in the farm woods.

Variants and synonyms: OAK—HICKORY, Illick, Penn. Dept. Forests and Waters, Bul. 11 (1914); Weaver and Clements, Plant Ecology (1929) 456; Telford, For. Surv. Ill., 3rd. Rpt. (1926) 54; Kittredge, Jour. For. 23 (1925) 890-895; Veatch, Mich. Agr. Exp. Sta. Quart. Bul. 10 (1928) 116-126. WHITE OAK—BLACK OAK, Kittredge, Mich. Agr. Exp. Sta. Spec. Bul. 190 (1929). BLACK OAK — WHITE OAK, Harvey, Mich. Acad. Sci. Rpt. (1919) 213-217. OAK RIDGE, Sherrard, Rpt. Mich. For. Com. (1902) 28-34. BUR—WHITE—RED OAK, Roth, U. S. F. Service, Bul. 16 (1898). OAK—MAPLE, Chamberlain, Geol. of Wisc. 2, (1877) 176. MIXED HARDWOODS, Telford, For. Surv. Ill., 3rd. Rpt. (1926) 11. BLACK OAK, Brown, Mich. Acad. Sci. 19th. Rpt. (1917) 209-217.

TYPE 50 WHITE OAK

Composition: White oak pure or predominant.

Chief associates: black oak, yellow poplar, chestnut, shagbark and mockernut hickories.

Occurrence: Throughout the central forest on well-drained loamy soils.

Place in succession: May be permanent on some sites.

Importance: Of secondary importance due to limited area except in the Ozark region.

Variants and synonyms: A WHITE OAK—BLACK OAK type was found by McCarthy to exist in southern Indiana as a narrow zone between the SCARLET OAK—BLACK OAK and the WHITE OAK types.

TYPE 51 RED OAK—BASSWOOD—WHITE ASH

Composition: Red oak, basswood and white ash forming the whole or a predominant part of the stand.

Associates: in New England red maple (characteristic), yellow birch, aspen, sugar maple, paper birch and beech; in New York and western Pennsylvania to the above list often add black cherry, white oak, black birch, butternut, American elm and hemlock; in the Southern Appalachians and middle western states yellow buckeye, yellow birch, chestnut, black birch, sugar maple and black cherry. In Iowa shagbark hickory replaces basswood. White ash is generally unimportant or absent in the Southern Appalachians.

Occurrence: Throughout the central forest and southern part of northern forest. In Appalachian Mountains from West Virginia to northern Georgia type is located at elevations between 3,000 and 5,500 feet. Elsewhere occurs at low elevations.

Occupies deep, fertile, moist, well-drained soils. In Iowa seeks areas slightly ill-drained bordering swamps.

Place in succession: Semi-permanent although the proportion of hemlock and sugar maple tends to increase.

Importance: Relatively important in central New England and New York due to area covered and commercial value. Elsewhere of minor importance.

Variants and synonyms: BUCKEYE — BASSWOOD, S. A. S. Com., Jour. For. 24 (1926) 677. TRANSITION HARDWOODS, Spaeth, Harvard Forest Bul. 2 (1920). OAK—MAPLE, Kittredge, Jour. For. 23 (1925) 890-895 is a Lake States variant with more white oak and sugar maple. MOUNTAIN LIN — YELLOW BUCKEYE — WHITE ASH, Ashe. Jour. Elisha Mitchell Sci. Soc. 37 (1922) 193. BLACK CHERRY—SUGAR MAPLE—MOUNTAIN LIN—BLACK BIRCH, Ashe, (loc. cit.).

TYPE 52 RED OAK

Composition: Red oak pure or predominant.

Associates: black oak, scarlet oak, chestnut oak, chestnut and yellow poplar.

Occurrence: Southern Appalachian Mountains from West Virginia to northern Georgia, at elevations of 2,000 to 3,000 feet in West Virginia and 3,000 to 5,500 feet in North Carolina.

Spotty distribution, occurring on ridge crests and north slopes in park-like stands.

Place in succession: Climax type.

Importance: Of secondary commercial importance. The trees are short-bodied and flat-topped.

Variants and synonyms: NORTHERN RED OAK, S. A. S. Com., Jour. For. 24 (1926) 677.

TYPE 53 YELLOW POPLAR

Composition: Yellow poplar pure.

Associates: black locust, red maple, black birch, red oak, cucumber magnolia and other moist site species.

Occurrence: Appalachian Mountains and adjoining portions of the central forest, at altitudes of from 500 feet (or less in the north and west) to 4,000 feet in the southern Appalachian Mountains.

On moist lower slopes, northerly slopes, moist coves and flats. Usually in small scattered stands. Frequently in more or less interrupted strips at bottoms and sides of mountain coves.

Place in succession: Characteristically a second-growth and temporary type often found on old fields. In small patches yellow poplar still predominates in old growth stands, and the yellow poplar type may once have been extensive in the virgin forest. In its pure form the yellow poplar type is not a climax. Stoneburner, for the Unaka National Forest, reports the yellow poplar type as rapidly replacing white pine—hemlock stands after logging.

Importance: Extremely important in the Appalachians both commercially and in aggregate area. Relatively accessible, due to its occurrence in coves and on lower slopes.

TYPE 54 YELLOW POPLAR—HEMLOCK

Composition: Yellow poplar and hemlock predominating.
Associates include chestnut, basswood, black gum, red oak, white ash, black oak, white oak, sugar maple and cucumber magnolia.

Occurrence: Appalachian and Cumberland mountains from Kentucky to northern Georgia, at altitudes between 2,000 and 4,000 feet. Found only in virgin stands, not in second-growth.
Occupies moist coves, flats and ravines. Strips along larger stream bottoms to foot of the slopes.

Place in succession: Unknown.

Importance: Commercially important where hemlock bark and pulpwood can be sold. Poplar is of excellent quality as fires do little damage. Aggregate area small.

TYPE 55 YELLOW POPLAR—WHITE OAK—RED OAK

Composition: Yellow poplar, white oak and red oak predominant.
Associates: chestnut, black oak, hemlock, black gum, hickories and other species c the moist sites.

Occurrence: Southern Appalachia mountain ranges, between altitud of 500 and 4,000 feet on norther slopes, coves, and moist flats.
Irregular and "spotty," but may form con siderable strips on moist slopes.

Place in succession: Unknown.

Importance: Important commerciall as well as in area and location.

Variants and synonyms: YELLOW POP LAR — CHESTNUT. Described b Shields and Wasilik for the Nan tahala National Forest as contai ing 70 per cent of yellow popla and chestnut associated with whit red and black oaks, hemlock an black gum. Found on moist site along streams at the lower elev tions (2,500-3,000 feet). Also re ognized as YELLOW POPLAR—CHES NUT — RED OAK — HEMLOCK, Ash Jour. Elisha Mitchell Sci. Soc. 3 (1922) 193-4.

YELLOW POPLAR—WHITE OAK—SUGAR MA PLE. Characteristically developed in mid dle Kentucky and Tennessee, southward t Sand Mountain in northern Alabama much of it on limestone soil. Generally a altitudes of less than 3,000 feet. Ash (loc. cit.). Also reported from West Vi ginia.

YELLOW POPLAR — WHITE OAK — BLAC GUM—RED MAPLE. Described by Ash (loc. cit.), as indicating the wettest site o which yellow poplar naturally grows.

YELLOW POPLAR — WHITE OAK — BLAC OAK — MOCKERNUT HICKORY. Describe by Ashe, (loc. cit.) as typically develope on sandy soils, often calcareous, on th Cumberland Mountains in Tennessee an Sand Mountain in Alabama.

YELLOW POPLAR—WHITE OAK. Describe by Shields and Wasilik, for the Nantaha National Forest, as containing 60 per ce of yellow poplar and white oak, associate

ith hemlock, white pine, basswood and h.

TYPE 56 CHESTNUT

Composition: Chestnut pure or predominant.

ssociates: chestnut oak, yellow poplar, d oak, white oak, black oak, scarlet oak, ickories, black gum, black birch, bassood, sugar maple and beech; in the north-n Piedmont Plateau southern red oak, irginia pine, scarlet oak, black oak and ickories.

Occurrence: Extended formerly from southern Maine and New Hampshire down the Appalachian and Cumberland Mountains into northern Georgia and Alabama. The death of chestnut from the blight has restricted the geographical range of the type. It now exists only in the mountains from West Virginia south at altitudes of 1,300 to 4,500 feet on northerly and to 5,500 feet on southerly exposures. Throughout its range chestnut is dying and the type seems doomed to extinction.

ccupies moist northerly slopes and coves, xtending to southerly exposures at somehat higher elevations. Often on crests of igh ridges at 4,500 to 5,500 feet.

ay occur in large stands on suitable sites ut with no particular zonal distribution.

Place in succession: Future composition following the death of the chestnut cannot be accurately foreseen. Chestnut oak appears to be an abundant species in the replacement. At high altitudes red oak will probably succeed the chestnut in mixed stands of these species, converting them largely into red oak type.

Importance: Very important in area and commercially so long as the chestnut remains alive or merchantable.

Variants and synonyms: OAK—CHESTNUT, Weaver and Clements, Plant Ecology (1929) 455.

TYPE 57 BEECH—SUGAR MAPLE

Composition: Beech and sugar maple pure or predominating.

Associates: red maple, white oak, red oak, hemlock, red elm, American elm, basswood, pignut, shagbark and mockernut hickories and black cherry.

Occurrence: Ohio Valley and southern Michigan.

In zones determined by soil moisture and temperature factors throughout area of early Wisconsin glaciation. In valleys of southwestern Pennsylvania, southeastern Ohio and mountainous part of Kentucky. Occurs at level of Tennessee Valley near Union, Tenn.

Morainal hills of Ohio, central Indiana and adjacent Michigan, also lower slopes of valleys and talus slopes under cliffs. Common on moist shale formations.

Place in succession: Climax while moisture conditions remain stable.

Importance: One of the most important types from northeastern Ohio to eastern Indiana.

Variants and synonyms: SUGAR MAPLE—BEECH, Jennings, Proc. Penn. Acad. Sci. 1 (1927).

TYPE 58 BEECH

Composition: Beech pure or predominating.

Associates: Sugar maple, yellow poplar, pin oak, red gum, red maple, red oak, white ash, red elm, American elm, white oak, mockernut, pignut and bitternut hickories.

Occurrence: Middle western states.

Type created and extended by cutting through northern and eastern Ohio into central Indiana. Common in "flats" of Indiana and along all stream courses of mountain and hill region where heavy soils are poorly drained.

Clay land such as Clermont silt loam and

flat ridges of central Ohio, poorly drained but with drainage enough to permit entry of beech.

Widely distributed—most common single species type in Ohio and Indiana.

Pure stands of beech occasionally occur on rocky stream flats in Southern Appalachains at elevations of 2,500 to 3,000 feet.

Place in succession: Climax. Hard to displace once cultural practice (cuttings), favors the beech.

Importance: Next in importance to principal oak types.

Variants and synonyms: PIN OAK.

TYPE 59 RIVER BIRCH—SYCAMORE

Composition: River birch and sycamore predominating.

Associates include red maple, black willow and other moist site hardwoods.

Occurrence: Southern New England, New Jersey, Pennsylvania, southern Lake States, tributaries of the Ohio and Mississippi Valley to Oklahoma and Tennessee, Allegheny and Piedmont Plateaus, reaching altitudes of 1,000 feet in the northern and 2,500 feet in the southern parts of the Appalachian Mountains. Scattered along river valleys in southern forest in Georgia.

Moist soils at the edges of creeks and rivers. In strips along streams and in small stands in moist places.

Place in succession: Unknown.

Importance: Widely distributed but of minor importance, commercially and in area.

Variants and synonyms: RIVER-EDGE HARDWOODS, S. A. S. Com., Jour. For. 24 (1926) 682. SYCAMORE, Brown, Mich. Acad. Sci. 19th. Rpt. (1917) 209-217. RIVER BIRCH — SYCAMORE — RED MAPLE — BLACK WILLOW, Ashe, Jour. Elisha Mitchell Sci. Soc. 37 (1922) 196.

TYPE 60 SILVER MAPLE—AMERICAN ELM

Composition: Silver maple and American elm predominant.

Associates: red maple, slippery elm, cottonwood, white or green ash and many other moist site hardwoods varying with the region.

Silver maple is the indicator species.

Occurrence: Throughout the centra[l] forest.

On silty soils of river bottoms and floo[d] plains. Soils usually poorly-drained. Occasionally in swamps. Occurs in long strip[s] along the larger streams and sometimes o[n] low lake shores.

Place in succession: Often follow[s] cottonwood and willow stands. Gradually succeeded by sugar maple—basswood or other hardwoo[d] types as drainage of the site matures.

Importance: Relatively small in area and unimportant commercially.

Variants and synonyms: SILVER MAPLE — ELM — ASH — HICKORY an[d] SILVER MAPLE—ASH—BASSWOOD—SWAMP WHITE OAK, Veatch, Mich. Agr. Exp. Sta. Quart. Bul. 1[…] (1928) 116-126. SILVER MAPLE, Brown, Mich. Acad. Sci. 19th Rp[t]. (1917) 209-217.

TYPE 61 COTTONWOOD

Composition: Cottonwood pure o[r] predominant. Four different tree[s] are included under type name a[s] here used. They are as follows: Southern cottonwood *Populus de[l]toides virginiana* (Castiglioni) Suc[…]worth, eastern cottonwood *Populu[s] deltoides* Marshall, cottonwood *Pop[ulus] sargentii* Dode and swam[p] cottonwood *Populus heterophyll[a]* Linnaeus.

Chief associates (particularly in younge[r] stages) sandbar willow and peachleaf wi[l]low. Other associated species, as invaders [of] the next successional stage, are subordinat[e]

'hey include sycamore, red gum, river irch, white or green ash, American or lippery elm, silver maple and red maple.

Occurrence: Throughout the central forest and southern forest, but particularly the Mississippi, Ohio and Missouri river systems.

Sandy, gravelly or silty soils of river bottoms and flood-plains. Rich alluvial oils and river sandbars. Wherever moist, bare soil is available.

In narrow strips along the larger streams on the first bottoms and in the lower Mississippi Valley on batture land (i. e., land between levee and river) and on old fields, (especially old cotton or corn fields).

In the central forest has been planted on upland prairie soils as shelter-belts.

Place in succession: Temporary. Pioneer or follows willow in seizing newly made sandbars. Succeeded by silver maple—American elm, red gum and other hardwood types. May be permanent on overflowed sandbars and flats in the batture lands.

Importance: Very important along the Mississippi River.

On the Missouri River drainage the scarcity of forest on sites other than stream bottoms increases the relative importance of the cottonwood type.

Variants and synonyms: COTTONWOOD—WILLOW, Kittredge, Jour. For. 23 (1925) 890-895; Lentz, Jour. For. 29 (1931) 1052. WILLOW—POPLAR, Bergman and Stallard, Minn. Bot. Std. 4, part 4, (1916) 333-378. COTTONWOOD—SYCAMORE stands are recognized locally in the southern states.

In the bottomlands of the Missouri River and tributaries (west of Iowa and Missouri) the cottonwood is *Populus sargentii.* The associates comprise American elm, green ash, boxelder and willows. Overflow land, both rich alluvial soils and river sandbars, are occupied. Considered here a climax type. Used for firewood and rough construction work on farms.

TYPE 62 SAND PINE

Composition: Sand pine predominant. Chief associates: myrtle oak, Florida hickory *Hicoria floridana* and Chapman white oak. Other associates include holly, (var. *arenicola*), turkey oak and live oak, (var. *geminata*).

Occurrence: Florida to Alabama on very dry, high sand ridges and coastal dunes.

Place in succession: Subclimax.

Importance: Not a valuable timber tree but dominant over many thousand acres of the poorest soil where no other tree of value can survive. Has possible use as pulp material.

Variants and synonyms: SCRUB, Harper, 3rd Ann. Report (1910) 224 and 18th Ann. Report, Fla. Geol. Surv. (1927) 79-81. SPRUCE PINE, Harper, 18th Ann. Report, Fla. Geol. Survey (1927) 79-81; Watson, Naturalist's Guide to the Americas (1926) 427-440.

TYPE 63 LONGLEAF PINE

Composition: Longleaf pine pure. Associates: on dry sites turkey oak and less abundantly blue-jack oak, blackjack oak and post oak; on moist sites slash pine, live oak (var. *geminata*) with some red gum, southern red oak and loblolly pine.

Occurrence: Hills and rolling country of upper Coastal Plain and also old coastal dunes in North Carolina, South Carolina, Alabama, Georgia, Florida, Louisiana and southern Mississippi.

In the flatwoods belt of the lower Coastal Plain on the drier sites of these poorly-drained soils.

Place in succession: May be climax on dry sites, elsewhere temporary or subclimax and succeeded by

slash pine, loblolly pine or by hardwoods.

Importance: Valuable for timber and naval stores.

Variants and synonyms: HILL PINE, LONGLEAF PINE FLATWOODS. FLATWOODS, Harper, Ann. Reports, Fla. Geol. Survey (1914) 330 and (1927) 82-87; Watson, Nat. Guide to the Americas (1926) 427-440; Ashe, Bull. 24 N. C. Geol. & Econ. Survey (1915) 14. HIGH PINE LAND, Harper, 18th Ann. Report, Fla. Geol. Survey (1927) 82-84. HIGH PINE WOODS, Watson, (loc. cit.). PINE BARRENS, Ashe, N. C. Geol. Survey Bull. 5 (1894) 34 and Bull. 24 (1915) 14; Luginbill, Nat. Guide to the Americas (1926) 419; Mohr Contr. to U. S. Nat. Herbarium 6 (1901) 96.

TYPE 64 LONGLEAF PINE—TURKEY OAK

Composition: Longleaf pine and turkey oak pure or predominating.

Associates: blue-jack oak, blackjack oak, post oak, persimmon, myrtle oak, laurel oak and live oak (var. *geminata*). The last three species are not common in the Carolinas.

Occurrence: Sand hill section of North Carolina and South Carolina at elevations of 200 to 400 feet above sea level and on coarse sands on Coastal Plain of North Carolina, South Carolina, Georgia, north Florida, Mississippi and eastern Louisiana.

The exclusive type on dry sand ridges and upper slopes and on rather large areas of well-drained coarse sands.

Place in succession: Often replaces longleaf pine after cuttings and repeated fires.

Importance: Of great economic importance since the area is extensive. This type has been commercially important as a source of turpentine and longleaf pine lumber, but lumbering, repeated fires and consequent lack of longleaf pine seed trees have made the valueless oaks predominant.

Variants and synonyms: LONGLEAF PINE SAND HILLS, Ashe, Bull. 24 N. C. Geol. and Econ. Survey (1915) 14.

TYPE 65 TURKEY OAK

Composition: Turkey oak pure or predominant.

Chief associates: blue-jack oak, post oak and blackjack oak (except in eastern Florida where live oak (var. *geminata*) replaces blackjack oak).

Minor associates; persimmon, hickory, myrtle oak and laurel oak.

Occurrence: Common in all the southeastern states on dry sand ridges formerly occupied by longleaf pine.

Place in succession: Doubtful. Originates when longleaf pine type is clear cut.

Importance: Of no commercial importance. A waste land type under present conditions.

Variants and synonyms: Often called SCRUB OAK RIDGE type. SAND RIDGE, Metcalf and Wells, Naturalist's Guide to the Americas (1926) 414.

TYPE 66 SOUTHERN RED CEDAR

Composition: Southern red cedar pure or predominant.

A variety of associates may be present including live oak (var. *geminata*), cabbage palmetto, evergreen magnolia, myrtle oak and sweet bay.

Occurrence: On extensive shell mounds along the Gulf Coast.

Place in succession: Subclimax. Live oak—cabbage palmetto is the probable climax type.

Importance: Valuable species but occupies relatively small area.

TYPE 67 LIVE OAK—CABBAGE PALMETTO

Composition: Live oak (var. *geminata*) and cabbage palmetto predominant.

Associates: southern red cedar and evergreen magnolia with smaller amounts of laurel oak, red maple, red bay and holly.

Occurrence: Beach dunes and calcareous hammocks mostly in Florida but extending northward into North Carolina.

Place in succession: Probably climax.

Importance: Unimportant.

Variants and synonyms: PALMETTO—LIVE OAK HAMMOCK. LIVE OAK HAMMOCK. PALM SAVANNA, Harper, 18th Ann. Report, Fla. Geol. Survey (1927) 100-101

TYPE 68 LOBLOLLY PINE—SHORTLEAF PINE

Composition: Loblolly pine and shortleaf pine alone or with such minor associates as hawthorn, persimmon, black gum, post oak, red oak and red gum.

Occurrence: Abundant in northern Mississippi and Louisiana and to a lesser extent wherever ranges of shortleaf and loblolly pines overlap.

Shortleaf pine predominates on drier ridges, while loblolly pine is found mostly on soils with a higher moisture content. Abandoned fields in the "hill prairies" of Mississippi are frequently taken possession of by shortleaf and loblolly pines.

Place in succession: Subclimax.

Importance: Of commercial importance.

Variants and synonyms: SHORTLEAF PINE HILLS, Goldsmith, Wyman and Kopman, Naturalist's Guide to the Americas (1926) 460.

TYPE 69 LOBLOLLY PINE

Composition: Loblolly pine pure or predominant.

Associates: red gum is characteristic; on fresh to moist sites add southern red oak, post oak and blackjack oak; on poorly-drained sites add black gum, water oak. yellow poplar and pond pine and in the far South tupelo gum and laurel oak.

Occurrence: Coastal Plain from Delaware and Maryland to Mississippi, Louisiana and eastern Texas. Occurs both on upland soils with abundant moisture but good drainage and also on poorly-drained depressions in the flatwoods. Largely on old fields or cutover areas of the longleaf pine flatwoods type.

Place in succession: Seizes abandoned fields. Succeeded by mixtures of loblolly pine and hardwoods.

Importance: Valuable timber type over extensive territory.

Variants and synonyms: OLD FIELD LOBLOLLY.

TYPE 70 LOBLOLLY PINE—SOUTHERN RED OAK

Composition: Loblolly pine and southern red oak predominating.

Associates: shortleaf pine, red gum, longleaf pine, post oak and persimmon.

Occurrence: Central and northern Louisiana and southern Arkansas. Clay ridges with fair drainage but with sufficient moisture in the ground.

Place in succession: Southern red oak tends to replace loblolly pine.

Importance: The loblolly pine is commercially important but not the oak on such sites.

TYPE 71 LOBLOLLY PINE—WHITE OAK

Composition: Loblolly pine and white oak predominating.

Associates: hickories, red maple, scarlet

oak, black oak, red oak, southern red oak, swamp red oak, post oak, willow oak, water oak, black gum, red gum, white ash, red ash and water ash.

Occurrence: Lower Piedmont Plateau and upper Coastal Plain between 100 and 600 feet above sea level in Maryland, Virginia and the Carolinas; probably also occurs farther south.

Moderately moist and fertile soils.

Place in succession: Probably a transition or tension zone type.

Importance: Important commercially and in area.

Variants and synonyms: PINE—OAK, Chrysler, Md. Weather Service 3.

TYPE 72 LOBLOLLY PINE—SLASH PINE

Composition: Loblolly pine and slash pine predominating.

Associates: red gum, water oak, laurel oak, yellow poplar, sweet bay, red bay, black gum, tupelo gum and American elm.

Occurrence: Coastal Plain from South Carolina to eastern Louisiana.

On old fields and on moist areas along small creeks sometimes on slightly rolling flatwoods.

Place in succession: Temporary.

Importance: Valuable timber type but limited in area.

TYPE 73 LONGLEAF PINE—SLASH PINE

Composition: Longleaf pine and slash pine alone or with a small mixture of water oak and laurel oak and occasionally post oak, blackjack oak and live oak.

On ground intermittently wet loblolly pine, sand pine, southern cypress, pond cypress, black gum and tupelo gum are characteristic associates.

Occurrence: Coastal Plain from Georgia to Louisiana. Usually second growth stands coming in on longleaf pine ridges in the flatwoods or in old fields. Also on borders of ponds on ground intermittently wet.

Place in succession: Temporary type caused by hogs tending to eliminate longleaf pine or by fire protection favoring slash pine. Probably succeeded by longleaf pine type.

Importance: Important timber type.

Variants and synonyms: FLATWOODS PINE. PALMETTO FLATWOODS, Harper, 4th Annual Report, Fla. Geol. Survey (1911) 66. PINE BARRENS, Hoke, Naturalist's Guide to the Americas (1926) 455. PINE BARREN FLATS, Harper, Naturalist's Guide to the Americas (1926) 116. PINE MEADOWS, Harper, 4th Annual Report, Fla. Geol. Survey (1911) 72.

TYPE 74 SLASH PINE

Composition: Slash pine ordinarily pure.

Chief associates: on moist areas pond cypress and swamp black gum with some red maple, red gum, sweet bay, loblolly bay, tupelo gum and pond pine; on limestone ridges in southern Florida live oak, gumbo-limbo, cabbage palmetto, stopper, thatch-palm and bustic.

Occurrence: Coastal Plains of Georgia, Florida, Alabama, Mississippi and Louisiana.

In shallow ponds on branch bottoms of flatwoods and on old fields.

Also found on limestone ridges along coast of southern Florida.

Place in succession: Subclimax.

Importance: Important timber type.

Variants and synonyms: FLATWOODS, Harper, 18th Ann. Report, Fla. Geol. Survey (1927). FLAT PINE WOODS, Harper, (loc. cit.). PALMETTO FLATWOODS, Sellards, 4th Ann. Report, Fla. Geol. Survey (1911) 66; Sellards and Gunter, 3rd Ann. Report, Fla. Geol. Survey (1910) 46. SLASH PINE BOGS and

BAYS, Harper, 3rd Ann. Report, Fla. Geol. Survey (1910) 256.

TYPE 75 CABBAGE PALMETTO—SLASH PINE

Composition: Cabbage palmetto and slash pine predominate.

Associates: on marshes close to the coast pond pine and a scattering of red gum and loblolly pine; on flatwoods areas in southern Florida live oak (var. *geminata*) and myrtle oak.

Occurrence: Coastal Plain of Georgia and Florida on marshes close to coast or on flatwoods areas in southern Florida.

Importance: Important timber type.

Variants and synonyms: DRY PRAIRIE, Harper, 18th Ann. Rep., Fla. Geol. Survey (1927) 87. MARLY FLATWOODS, Harper, (loc. cit.) 173. PALMETTO BELT, Fox, Naturalist's Guide to the Americas (1926) 424.

TYPE 76 WATER OAK—WILLOW OAK

Composition: Water oak and willow oak together or singly forming practically the entire stand.

Occurrence: A flatwoods type scattered infrequently through the pine region of eastern Texas (but particularly in the northern part), and southeastern Oklahoma.

Place in succession: Doubtful.

Importance: Produces some valuable oak lumber and tie timber.

Variants and synonyms: OAK GLADE.

TYPE 77 RED GUM—YELLOW POPLAR

Composition: Red gum and yellow poplar predominating.

Associates: loblolly pine, red maple, white ash, red ash and other moist site hardwoods.

Occurrence: Reaches maximum importance in Coastal Plain from Maryland to central Florida. Extends into the Piedmont Plateau, but is there of less importance.

Occupies moist lower slopes, but does not extend into swampy ground.

Moisture conditions limit the type to lower slopes and limit its occurrence to belts between stream swamps and upper slopes.

Place in succession: Reproduces itself after logging and takes possession of abandoned farm land on the lower slopes. Probably climax on certain sites as both the red gum and yellow poplar reach large sizes and reproduce under their own shade.

Importance: An important type as both red gum and yellow poplar are used extensively for furniture and veneers. Yellow poplar is also used for pulpwood.

Variants and synonyms: BOTTOMLAND HARDWOOD, S. A. S. Com., Jour. For. 24 (1926) 683.

TYPE 78 LIVE OAK

Composition: Live oak pure or predominant.

Associates: red gum, evergreen magnolia, holly, laurel oak, water oak, and hawthorn.

Occurrence: Southern Louisiana along well-drained borders of tidal marshes.

Place in succession: Climax.

Importance: Commercially practically worthless and of limited area.

TYPE 79 BEECH—EVERGREEN MAGNOLIA

Composition: Beech is the indicator species and is often the most abundant. A great variety of other hardwoods occur. Common associates include black gum, yellow poplar, swamp red oak and southern red oak.

Occurrence: Loess ridges, ravines and branch bottoms between these ridges and branch bottoms intersecting many of the pine lands in

Louisiana, Arkansas and Mississippi. Also on hammocks of southern Louisiana. Widely distributed.

Place in succession: Climax.

Importance: Important in loess region as it contains best merchantable timber. Less important in the hammocks.

Variants and synonyms: UPLAND HARDWOODS used in the Mississippi Delta by the Forest Survey, Southern Forest Experiment Station.

TYPE 80 HICKORY—SWAMP CHESTNUT OAK — WHITE OAK

Composition: At least six species of hickory, (shagbark, bigleaf shagbark, pignut [*H. leiodermis*], mockernut, nutmeg and bitternut), together with swamp chestnut oak, white oak, post oak and/or a related species *Quercus mississippiensis* Ashe, predominate. Hickories and oaks of the white oak group are always predominant; but the two oaks mentioned in the type name, although commonest of the oaks, are not indicator species or even present in certain cases.

Associates: Nuttall's oak, water oak (*Q. nigra*), overcup oak, red gum, American elm, green ash, sugarberry and numerous other hardwoods forming a widely variable mixture.

Occurrence: Throughout the southern forest within the alluvial floodplains usually on loamy ridges but sometimes, in the northern part of the Mississippi Delta, on loamy flats in second bottoms.

Place in succession: Doubtful.

Importance: Widely distributed but does not occur in large contiguous areas.

Variants and synonyms: Probably no one species of oak or hickory predominates except locally, and many different local types will be found. OAK—HICKORY, Lentz, Jour. For. 29 (1931) 1052.

TYPE 81 RED GUM—SWAMP RED OAK

Composition: Swamp red oak is often only an indicator although usually the most abundant of the oaks. Under the name swamp red oak are included both *Quercus rubra pagodaefolia* and *Quercus rubra leucophylla*.

Chief associates: swamp chestnut oak, water oak, white oak, ashes (probably largely white ash), post oak, hickories and black gum.

Minor associates include honey locust, willow oak, Shumard red oak, American elm, and southern red oak.

Occurrence: Throughout the southern forest within the alluvial floodplains; on very high flats or ridges, distinctly elevated above typical low flats or glades. The soil is a silty clay, silty clay loam, silt loam or sandy loam, and fairly well to well-drained. These ridges may be either extensive or much interrupted by intervening low flats supporting a different type. The site is usually never covered with standing water and rarely if ever overflowed except at times of exceptionally high water, as in 1927.

Place in succession: Unknown.

Importance: Very important, due both to extensive distribution and abundance in both small and large areas and to value of principal species.

Variants and synonyms: Any one or two of the predominant species or chief associates may be most prominent on any given area. RED GUM—COW OAK and CHERRYBARK OAK—WATER OAK are, for example common variants.

Names commonly used in the Mississippi Delta are RED GUM—CHERRYBARK OAK or RED GUM—LOAMY RIDGE OAKS, Lentz, Jour. For. 29 (1931) 1052.

TYPE 82 RED GUM

Composition: Red gum pure or predominant.

Chief associates: water oak, Nuttall's oak, American elm, willow oak, sugarberry, green ash, and white ash.

There are many minor associates.

Occurrence: Throughout southern forest within the alluvial flood-plains on high flats or low ridges. Areas not annually overflowed. Soils usually silty or loamy or, if a clay top soil occurs, it is usually underlain by sandy loam subsoil. Also found on old fields, once cultivated, where soil receives abundant moisture but is well-drained.

Place in succession: Doubtful.

Importance: Very important due to value of the species.

TYPE 83 RED GUM — NUTTALL'S OAK — WILLOW OAK

Composition: Red gum, Nuttall's oak and willow oak predominating. Nuttall's oak although the commonest oak in the type should be considered as an indicator species. Red gum is generally not as common as the oaks.

Chief associates: pin oak (rare or absent south of central Arkansas and northern Mississippi), overcup oak, water oak (*Quercus obtusa*), only in central and southern Louisiana, bur oak (same approximate range as pin oak), American elm and green ash.

Occurrence: Mississippi Delta in the alluvial flood-plains. On poorly-drained flats where a shallow sheet of water usually stands during the winter.

Place in succession: Unknown.

Importance: Quite important on flats.

Variants and synonyms: RED GUM—CLAY FLAT OAKS, Lentz, Jour. For. 29 (1931) 1052.

TYPE 84 WILLOW OAK

Composition: Willow oak is an indicator species and not always predominant, although it may be so. In general no one or two species are predominant. This is the only type where willow oak and swamp red oak occur together.

Chief associates: swamp red oak, swamp chestnut oak, Nuttall's oak, winged elm (chiefly in second bottoms) and cedar elm (chiefly in first bottoms). Many other hardwood species may appear in the mixture.

Occurrence: Mississippi Delta on alluvial flood-plains principally on sites having characteristics (of soil, moisture, elevation and overflow) midway between those of typical flats or glades and those of typical ridges. Topography is frequently undulating or washboardy, with a resultant mixture of flat and ridge conditions.

On poorly-drained flats principally on second bottoms.

Place in succession: When heavily cut usually succeeded by the oak—elm—ash type.

Importance: Very common but ordinarily not covering large individual areas.

Variants and synonyms: Any of the principal species may be locally predominant. Grades into types containing red gum and either the oaks of the flats or those of the ridges. BOTTOMLAND OAKS, Lentz, Jour. For. 29 (1931) 1052.

TYPE 85 SUGARBERRY—ELM

Composition: Sugarberry, American elm, winged elm and cedar elm predominate.

Associates depend upon what the type was previous to cutting.

Occurrence: Throughout the southern forest within the alluvial flood-

plains. May occur anywhere except in sloughs, along bayous or in deep swamps.

Place in succession: Temporary. Usually a residual type found after heavy cutting.

Importance: Usually worthless commercially but widespread and from that viewpoint important.

Variants and synonyms: HACKBERRY—ELM, Lentz, Jour. For. 29 (1931) 1053.

TYPE 86 OAK—ELM—ASH

Composition: Mixtures of five oaks, three elms and two ashes in a variety of combinations are characteristic.

Predominant species are: willow oak, water oak, overcup oak, Nuttall's oak, swamp red oak, American elm, winged elm, cedar elm, green ash and white ash. Usually only one (occasionally two) species of elm is abundant in any given stand.

Other minor associates are present.

Occurrence: Throughout southern forest in the alluvial flood-plains.

Most common on poorly-drained flats but may occur on any cutover areas.

Place in succession: Usually a residual type, following cutting in the red gum — Nuttall's oak — willow oak type or in the willow oak type.

Importance: Not usually important commercially but occasionally a source of much ash.

Variants and synonyms: Common variants are WILLOW OAK—CEDAR ELM, GREEN ASH, and GREEN ASH—MIXED HARDWOODS. OAK — ELM, Lentz, Jour. For. 29 (1931) 1053.

TYPE 87 SOUTHERN CYPRESS—HARDWOOD

Composition: Southern cypress and a complex and widely varying admixture of hardwood species.

Chief associates: ash (probably green or, at the north, water ash), red gum, red maple and silver maple (only from central Arkansas and northern Mississippi northward).

Other associates include overcup oak, Nuttall's oak, water hickory, American elm, pin oak (same approximate range as silver maple) and sugarberry.

Occurrence: Throughout the southern forest in the alluvial flood-plains on areas where water stands at frequent intervals and which can be classed as flats rather than swamps. The soil is generally either a clay or a silty clay loam. The cypress is ordinarily without knees or with knees of low height.

Place in succession: Climax. With cutting of cypress has reverted in many cases to red gum type or red gum — Nuttall's oak — willow oak type.

Importance: Originally important, now of minor importance. Common in Arkansas.

Variants and synonyms: CYPRESS — HARDWOOD, Lentz, Jour. For. 29 (1931) 1052.

TYPE 88 WILLOW

Composition: Willow usually pure or in some cases predominant. Several species of willow are included. Black willow is the commonest species.

Chief associates: southern cottonwood, swamp privet and water locust.

Occurrence: Throughout southern and central forest in alluvial flood-plains. Along river's edge and in the Mississippi Delta on low "batture" land, usually annually overflowed.

Place in succession: First to appear on river margins, almost to the exclusion of any other species. Replaced by other types as soil is built up. Cottonwood usually is the first to replace willow.

Importance: Extensive along Missis-

sippi, Red, Yazoo and Atchafalaya Rivers in Louisiana and Mississippi.

Variants and synonyms: COTTONWOOD—WILLOW, Kittredge, Jour. For. 23 (1925) 890-895; Lentz, Jour. For. 29 (1931) 1052. WILLOW—POPLAR, Bergman and Stallard, Minn. Bot. Std. 4, part 4 (1916) 333-378.

TYPE 89 OVERCUP OAK—WATER HICKORY

Composition: Overcup oak and water hickory predominate.

Chief associates: green ash, willow oak, persimmon, Nuttall's oak, American elm and red maple.

Minor associates: southern cypress, red gum, water oak and cedar elm.

Occurrence: Throughout the southern forest in the alluvial flood-plains. On poorly-drained clay flats in first bottoms (principally in Louisiana and Mississippi), and in poorly drained depressions, sloughs and shallow swamps in second bottoms throughout the Mississippi Delta, especially the southern half.

Place in succession: Climax.

Importance: Secondary, due to poor form and slow growth.

Variants and synonyms: OVERCUP OAK—PECAN, Lentz, Jour. For. 29 (1931) 1053.

TYPE 90 SOUTHERN WHITE CEDAR

Composition: Southern white cedar characteristically in pure even-aged stands, although sometimes only predominating.

Associates apt to increase in abundance after fire or cutting.

Associates include: in the North, gray birch, pitch pine and black gum; elsewhere pond pine, southern cypress, swamp black gum, sweet bay, red bay, loblolly-bay, slash pine, spruce pine and titi. Red maple is a common associate throughout the entire range.

Occurrence: In many detached tracts in Coastal Plain from southern Maine to northern Florida and southern Mississippi in a comparatively narrow zone near the coast. Most abundant in Coastal Plain of New Jersey, North and South Carolina and western Florida. Occasional swamp in hills of northern New Jersey. Confined to sandy-bottomed, usually peaty, interior and river swamps, wet depressions and stream banks.

Place in succession: A second-growth type, largely in even-aged stands, which apparently under natural succession tends to be replaced slowly by swamp hardwoods, especially on the more fertile soils. Pure stands occur on areas of swamp peat overlying a sandy subsoil; but as the quantity of silt and clay in the underlying subsoil increases, the proportion of swamp hardwoods, increases until southern white cedar can no longer compete with them. Pure stands of cedar frequently follow slash fires which occur when the swamps are full of water. After fires which occur when the water table is low enough to permit the upper layers of peat to be burned, the cedar may be replaced by swamp hardwoods.

Importance: A valuable type because of the excellent technical qualities of southern white cedar. Relatively limited in area particularly north of New Jersey.

Variants and synonyms: JUNIPER GLADE or CEDAR GLADE are often used locally, Korstian, Tech. Bul. 251, U. S. D. A. 1931.

TYPE 91 POND PINE

Composition: Pond pine pure or predominant.

Chief associate: slash pine (not found in North Carolina).

Minor associates include loblolly pine, pond cypress, red gum, sweet bay, loblolly-bay, red bay and swamp black gum.

Occurrence: Coastal Plain from North Carolina to Florida on flatwoods near the coast or in bays and ponds.

Place in succession: Probably climax type.

Importance: Poor timber but of some economic importance. A fairly extensive type.

Variants and synonyms: POND PINE POCOSINS used locally. SAVANNA PINE, Ashe, N. C. Geol. Survey Bul. 5 (1894) 17. SPRUCE PINE, Ashe, (loc. cit.). POCOSIN PINE, Ashe, (loc. cit.). POCOSIN PINE and BAYS, Ashe, N. C. Geol. Survey Bul. 24 (1915) 15.

TYPE 92 SLASH PINE—SWAMP BLACK GUM

Composition: Slash pine and swamp black gum predominating.

Associates: in ponds in the flatwoods pond cypress, black gum, red maple, sweet bay and loblolly-bay; in smaller creeks and branches swamp ironwood, titi, water ash, red maple, American elm and pond pine; in shallow ponds yaupon, dahoon (var. *myrtifolia*) and pond pine.

Occurrence: Coastal Plain of Georgia, Florida and Alabama.

In ponds in the flatwoods, in smaller creeks and branches and in shallow ponds.

Place in succession: Subclimax.

Importance: Slight.

TYPE 93 POND CYPRESS

Composition: Pond cypress predominant or sometimes only an indicator species.

Associates: in Georgia, Florida, and Alabama. swamp black gum, slash pine, yaupon, dahoon, titi, and black willow; in the Carolinas swamp black gum and swamp ironwood.

Occurrence: Coastal Plain from North Carolina through Florida to southern Alabama.

Shallow ponds and flatwoods wet most of the year in flatwoods region.

Place in succession: Doubtful.

Importance: Covers 20 to 30 per cent of the area in many counties; valuable for ties but not as good as southern cypress.

Variants and synonyms: BAY, Harper, 6th. Ann. Report, Fla. Geol. Survey (1914) 248. BAY-GALL, Harper, (loc. cit.). CYPRESS SWAMP, Metcalf and Wells, Naturalist's Guide to the Americas (1926) 414; Watson, Naturalist's Guide to the Americas (1926) 430. CYPRESS PONDS, Harper, 3rd. Ann. Report, Fla. Geol. Survey (1910) 264.

TYPE 94 SOUTHERN CYPRESS

Composition: Southern cypress pure or predominating.

Associates: tupelo gum in south (black gum in extreme north), red maple, planer tree, water oak, and swamp black gum.

Occurrence: Coastal Plain from Delaware and Maryland to Texas and in alluvial flood-plains throughout Mississippi and Louisiana northward into Arkansas and Tennessee.

Sloughs, margins of bayous, deep swamps and river bottoms wet all the year.

Place in succession: Climax. After cutting may revert to tupelo gum type.

Importance: A valuable and important type.

Variants and synonyms: CYPRESS — TUPELO, Foster et al, Bul. 3, A. & M. Coll. Texas (1917) 24; Lentz, Jour. For. 29 (1931) 1051-52. SOUTHERN CYPRESS—TUPELO GUM used locally in the Coastal Plain of Virginia and the Carolinas where mixtures of southern cypress and tupelo gum are customarily found rather than pure stands of either species. CYPRESS BRAKES, Foster, Bul. 114 U. S. D. A. (1912) 46. CYPRESS and

HARDWOODS, Foster, (loc. cit.). BALD CYPRESS—TUPELO GUM, Foster, et al, Bul. 3, A. & M. Coll. Texas (1917) 24.

TYPE 95 TUPELO GUM

Composition: Tupelo gum pure or predominating.

Associates: southern cypress, red maple, swamp black gum, pumpkin ash and (in the north) water ash.

Occurrence: Coastal Plain from Virginia to Texas and in alluvial floodplains throughout Mississippi and Louisiana northward into Arkansas and Tennessee.

In deep swamps, sloughs and margins of bayous. Frequently occupies deeper swamps or sloughs than the southern cypress type.

Place in succession: Probably climax except where it appears as residual stands after cypress has been cut.

Importance: Due to dense stands and large areas the type is important.

Variants and synonyms: SWEET BAY—SWAMP BLACK GUM; on smaller creeks and minor river bottoms and in ponds within the uplands sweet bay and swamp black gum may predominate sometimes to the complete exclusion of tupelo gum. Lack of knowledge as to the extent and exact composition of such stands have led to their inclusion as a variant under type 95.

SOUTHERN CYPRESS — TUPELO GUM used locally in the Coastal Plain of Virginia and the Carolinas where mixtures of southern cypress and tupelo gum are customarily found rather than pure stands of either species.

CYPRESS—TUPELO, Foster et al, Bul. 3, A. & M. Coll. Texas (1917) 46; Lentz, Jour. For. 29 (1931) 1051-52. BALD CYPRESS—TUPELO GUM: Foster et al, (loc. cit.).

TYPE 96 MAHOGANY

Composition: Mahogany is the indicator species characterizing the type.

Chief associates: gumbo-limbo, wild fig, Jamaica dogwood and mastic.

Minor associates include pigeon plum, cabbage palmetto, thatch-palm and several stoppers.

Occurrence: Dry hammocks and keys of south Florida.

Place in succession: Climax.

Importance: Unimportant.

Variants and synonyms: TROPICAL HAMMOCK. Watson, Naturalist's Guide to the Americas (1926) 434; Harper, 18th Ann. Report, Fla. Geol. Survey (1927) 106.

TYPE 97 MANGROVE

Composition: Mangrove pure or predominant.

Chief associates buttonwood, white buttonwood, cabbage palmetto and seagrape.

Minor associates: blackwood and golden fig.

Occurrence: Tidal swamps and islands in south half of Florida peninsula.

Place in succession: Climax.

Importance: Unimportant.

Variants and synonyms: MANGROVE SWAMP, Watson, Naturalist's Guide to the Americas (1926) 430; Harper, 3rd. Annual Report, Fla. Geol. Survey (1910) 233.

COMMON AND BOTANICAL NAMES OF THE TREE SPECIES MENTIONED IN THE TYPE DESCRIPTIONS

Common name	Botanical name	Type numbers[1]
Ash, Black	*Fraxinus nigra* Marshall	22, 23, 24, 25, 26
Ash, Blue	*Fraxinus quadrangulata* Michaux	46
Ash, Green	*Fraxinus pennsylvanica lanceolata* (Borkhausen) Sargent	4, 13, 21, 45, 49, 60, 61, 80, 82, 83, 86, 87, 89

Common name	Botanical name	Type numbers[1]
Ash, Pumpkin	*Fraxinus profunda* Bush	95
Ash, Red	*Fraxinus pennsylvanica* Marshall	71, 77
Ash, Water	*Fraxinus caroliniana* Miller	71, 87, 92, 95
Ash, White	*Fraxinus americana* Linnaeus	7, *8*, 9, 10, 11, 12, 14, 18, 26, 45, 49, *51*, 54, 58, 60, 61, 71, 77, 81, 82, 86
Aspen	*Populus tremuloides* Michaux	1, 3, *4*, 5, 6, 7, 9, 20, 21, 25, 46, 51
Aspen, Largetooth	*Populus grandidentata* Michaux	1, 3, 4, 5, 6, 8, 49
Basswood	*Tilia* Linnaeus	6, 8, 9, 10, 11, 12, *13*, 26, 45, 49, *51*, 54, 56, 57
Bay, Loblolly	*Gordonia lasianthus* (Linnaeus) Ellis	90, 91, 92
Bay, Red	*Persea borbonia* (Linnaeus) Sprengel	67, 72, 90, 91
Bay, Sweet	*Magnolia virginiana* Linnaeus	66, 72, 74, 90, 91, 92, 95
Beech	*Fagus grandifolia* Ehrhart	8, 9, 11, *12*, 15, 16, *17*, 18, 19, 22, 49, 51, 56, *57*, *58*, *79*
Beech, Blue	*Carpinus caroliniana* Walter	13, 45
Birch, Black	*Betula lenta* Linnaeus	8, 9, 10, 11, 12, 14, 46, 51, 53, 56
Birch, Gray	*Betula populifolia* Marsh	3, *7*, 9, 46, 90
Birch, Paper	*Betula papyrifera* Marshall *Betula cordifolia* Regel	1, 3, 4, *6*, 7, 8, 9, 10, 11, 12, 15, 16, 18, *20*, *21*, 23, 24, 51
Birch, River	*Betula nigra* Linnaeus	59, 61
Birch, Yellow	*Betula lutea* Michaux	6, 7, 8, 9, 10, 11, *12*, 13, 14, *15*, *16*, 18, 19, 20, 21, 22, 24, 26, 51
Blackwood	*Avicennia nitida* Jacquin	97
Boxelder	*Acer negundo* Linnaeus	4, 45
Buckeye, Ohio	*Aesculus glabra* Willdenow	12
Buckeye, Yellow	*Aesculus octandra* Marshall	15, 16, 18, 19, 51
Bustic	*Dipholis salicifolia* (Linnaeus) A. de Candolle	74
Butternut	*Juglans cinerea* Linnaeus	49, 51
Buttonwood	*Conocarpus erecta* Linnaeus	97
Buttonwood, White	*Laguncularia racemosa* (Linnaeus) Gaertner fils	97
Cedar, Eastern Red	*Juniperus virginiana* Linnaeus	7, 31, *46*
Cedar, Mountain	*Juniperus mexicana* Sprengel	*28*
Cedar, Northern White	*Thuja occidentalis* Linnaeus	18, 20, 21, 22, 23, *24*, 25, 26
Cedar, Southern Red	*Juniperus lucayana* Britton	*66*, 67
Cedar, Southern White	*Chamaecyparis thyoides* (Linnaeus) Britton, Sterns, and Poggenberg	90
Cherry, Black	*Prunus serotina* Ehrhart	8, 9, 10, 11, 12, 49, 51, 57
Cherry, Pin	*Prunus pennsylvanica* Linnaeus fils	4, *5*, 7, 9
Chestnut	*Castanea dentata* (Marshall) Borkhausen	9, 12, 33, 35, 36, 37, 44, *48*, 50, 51, 52, 54, 55, *56*
Chinquapin	*Castanea pumila* (Linnaeus) Miller	31, 35, 49
Cottonwood, Eastern	*Populus deltoides* Marshall	26, 45, 60, *61*
Cottonwood	*Populus sargentii* Dode	*61*
Cottonwood, Southern	*Populus deltoides virginiana* (Castiglioni) Sudworth	*61*, 88
Cottonwood, Swamp	*Populus heterophylla* Linnaeus	*61*
Cypress, Pond	*Taxodium ascendens* Brongniart	73, 74, 91, 92, *93*
Cypress, Southern	*Taxodium distichum* (Linnaeus) Richard	73, *87*, 89, 90, *94*, 95
Dahoon	*Ilex cassine myrtifolia* (Walter) Sargent	92, 93
Dogwood	*Cornus florida* Linnaeus	32, 33, 49
Dogwood, Jamaica	*Ichthyomethia piscipula* (Linnaeus) A. S. Hitchcock	96
Elm, American	*Ulmus americana* Linnaeus	4, 12, 13, *26*, 45, 46, 49, 51, 57, 58, *60*, 61, 72, 80, 81, 82, 83, 85, 86, 87, 89, 92

Common name	Botanical name	Type numbers[1]
Elm, Cedar	*Ulmus crassifolia* Nuttall	28, 84, *85*, 86, 89
Elm, Red	*Ulmus serotina* Sargent	57, 58
Elm, Rock	*Ulmus racemosa* Thomas	26
Elm, Slippery	*Ulmus fulva* Michaux	26, 60, 61
Elm, Winged	*Ulmus alata* Michaux	31, 32, 84, *85*, 86
Fig, Golden	*Ficus aurea* Nuttall	97
Fig, Wild	*Ficus brevifolia* Nuttall	96
Fir, Balsam	*Abies balsamea* (Linnaeus) Miller	4, 6, 11, 12, 16, 18, *20*, *21*, 22, 23, 24, 26
Fir, Southern Balsam	*Abies fraseri* (Pursh) Poiret	16, 18, *19*
Gum, Black	*Nyssa sylvatica* Marshall	26, 30, 31, 32, 33, 34, 35, 36, 37, 38, 40, 41, 42, 43, 44, 48, 49, 54, 55, 56, 68, 69, 71, 72, 73, 79, 81, 90, 92, 94
Gum, Red	*Liquidambar styraciflua* Linnaeus	44, 49, 58, 61, 63, 68, 69, 70, 71, 72, 74, 75, 77, 78, 80, *81*, *82*, *83*, 87, 89, 91
Gum, Swamp Black	*Nyssa biflora* Walter	74, 90, 91, *92*, 93, 94, 95
Gum, Tupelo	*Nyssa aquatica* Linnaeus	69, 72, 73, 74, 94, *95*
Gumbo-limbo	*Bursera simaruba* (Linnaeus) Sargent	74, 96
Hackberry	*Celtis occidentalis* Linnaeus	13, 28, 29, 45, 82
Hawthorn	*Crataegus* Linnaeus	19, 68, 78
Hemlock	*Tsuga canadensis* (Linnaeus) Carrière	3, 6, 8, 9, *10*, *11*, 12, 15, 17, 18, 19, 22, 24, 26, 48, 51, *54*, 55, 57
Hickories	*Hicoria* Rafinesque	30, 33, 34, 38, 39, 40, 41, 42, 43, 48, 55, 56, 65, 71, *80*, 81
Hickory, Bigleaf Shagbark	*Hicoria laciniosa* (Michaux f.) Sargent	45, 80
Hickory, Bitternut	*Hicoria cordiformis* (Wangenheim) Britton	49, 58, 80
Hickory, Florida	*Hicoria floridana* (Sargent) Sudworth	62
Hickory, Mockernut	*Hicoria alba* (Linnaeus) Britton	31, 49, 50, 57, 58, 80
Hickory, Nutmeg	*Hicoria myristicaeformis* (Michaux f.) Britton	80
Hickory, Pignut	*Hicoria glabra* (Miller) Sweet	31, 49, 57, 58
Hickory, Pignut	*Hicoria leiodermis* (Sargent) Sudworth	80
Hickory, Shagbark	*Hicoria ovata* (Miller) Britton	49, 50, 51, 57, 80
Hickory, Water	*Hicoria aquatica* (Michaux f.) Britton	87, *89*
Holly	*Ilex opaca* Aiton	29, 67, 78
Holly	*Ilex opaca arenicola* Ashe	*62*
Hop-hornbeam	*Ostrya virginiana* (Miller) Koch	13, 45
Ironwood, Swamp	*Cyrilla racemiflora* Linnaeus	92, 93
Locust, Black	*Robinia pseudoacacia* Linnaeus	33, 35, 46, *47*, 49, 53
Locust, Honey	*Gleditsia triacanthos* Linnaeus	81
Locust, Water	*Gleditsia aquatica* Marshall	88
Magnolia, Cucumber	*Magnolia acuminata* Linnaeus	10, 12, 18, 19, 53, 54
Magnolia, Evergreen	*Magnolia grandiflora* Linnaeus	66, 67, 78, *79*
Mahogany	*Swietenia mahagoni* Jacquin	*96*
Mangrove	*Rhizophora mangle* Linnaeus	*97*
Maple, Red	*Acer rubrum* Linnaeus	3, 5, 6, 7, 9, 10, 11, 12, 15, 16, 18, 20, 22, 23, 24, 25, *26*, 31, 32, 35, 36, 38, 44, 45, 46, 48, 49, 51, 53, 57, 58, 59, 60, 61, 67, 71, 74, 77, 87, 89, 90, 92, 94, 95
Maple, Silver	*Acer saccharinum* Linnaeus	26, *60*, 61, 87
Maple, Sugar	*Acer saccharum* Marshall	7, 8, 9, 10, 11, *12*, *13*, *14*, 15, 16, *17*, 18, 19, 21, 49, 51, 54, 56, *57*, 58
Mastic	*Sideroxylon foetidissimum* Jacquin	96
Mesquite	*Prosopis juliflora* (Schwartz) de Candolle	*27*
Mountain-ash	*Sorbus americana* Marshall	16, 18, 19

Common name	Botanical name	Type numbers[1]
Oak, Bear	*Quercus ilicifolia* Wangenheim	*35*
Oak, Black	*Quercus velutina* La Marck	2, 30, 31, *32*, *33*, 34, 35, 36, 37, 38, 39, 40, 42, 43, 44, 45, 46, *49*, 50, 52, 54, 55, 56, 58, 71
Oak, Blackjack	*Quercus marilandica* Muenchhausen	30, *31*, 32, 38, 39, 40, 41, 42, 43, 46, 63, 64, 65, 69, 72
Oak, Blue-jack	*Quercus cinerea* Michaux	63, 64, 65
Oak, Bur	*Quercus macrocarpa* Michaux	4, 26, *45*, 49, 83
Oak, Chapman White	*Quercus chapmanii* Sargent	62
Oak, Cherrybark	See swamp red oak. Cherrybark oak is the name locally used in the Mississippi Delta	81
Oak, Chestnut	*Quercus montana* Willdenow	3, 9, 10, 33, 35, *36*, 37, 42, 43, 44, *48*, 52, 56
Oak, Chinquapin	*Quercus muehlenbergii* Engelmann	30, 31
Oak, Cow	See swamp chestnut oak	81
Oak, Jack	*Quercus ellipsoidalis* E. J. Hill	1, *2*, 3, 45, 49
Oak, Laurel	*Quercus laurifolia* Michaux	64, 65, 67, 69, 72, 78
Oak, Live	*Quercus virginiana* Miller	73, 74, *78*
Oak, Live	*Quercus virginiana fusiformis* (Small) Sargent	28, 29
Oak, Live	*Quercus virginiana geminata* (Small) Sargent	62, 63, 64, 65, 66, *67*, 73, 74, 75
Oak, Mountain	See Schneck, red oak	29
Oak, Myrtle	*Quercus myrtifolia* Willdenow	62, 64, 65, 66, 75
Oak, Nuttall's	*Quercus nuttallii* Palmer	80, 82, *83*, 84, 86, 87, 89
Oak, Overcup	*Quercus lyrata* Walter	80, 83, 86, 87, *89*
Oak, Pin	*Quercus palustris* Muenchhausen	26, 45, 58, 86, 87
Oak, Post	*Quercus stellata* Wangenheim	*30*, *31*, *32*, 34, 36, 38, *39*, 40, 41, 42, 43, 46, 68, 69, 70, 71, 72, 80, 81
Oak, Post	*Quercus stellata margaretta* (Ashe) Sargent	63, 64, 65
Oak, Post	*Quercus mississippiensis* Ashe	80
Oak, Red	*Quercus borealis* Michaux f.	2, 3, 5, 6, 7, *8*, 9, 10, 11, 12, 13, 14, 35, 36, 41, 44, 45, 48, *51*, 52, 53, 54, *55*, 56, 57, 58
Oak, Red	*Quercus borealis maxima* (Marshall) Ashe	36, 41, 44, 48, *51*, 53, 54, *55*, 56, 57, 58, 68, 71
Oak, Scarlet	*Quercus coccinea* Muenchhausen	2, 9, 30, 31, 32, *33*, *34*, 35, 36, 37, 38, 39, *40*, 42, 43, 48, 49, 52, 56, 71
Oak, Schneck Red	*Quercus shumardii schneckii* (Britton) Sargent	28, 29, 30
Oak, Shin	*Quercus mohriana* Rydberg *Quercus annulata* Buckley	28, *29*
Oak, Shingle	*Quercus imbricaria* Michaux	30, 31
Oak, Shumard Red	*Quercus shumardii* Buckley	81
Oak, Southern Red	*Quercus rubra* Linnaeus	30, 32, *34*, 38, *40*, 41, 42, *43*, 56, 63, 69, *70*, 71, 79, 81
Oak, Swamp Chestnut	*Quercus prinus* Linnaeus	*80*, 81, 84
Oak, Swamp Red	*Quercus rubra pagodaefolia* (Elliott) Ashe *Quercus rubra leucophylla* Ashe	71, 79, *81*, 84, 86
Oak, Swamp White	*Quercus bicolor* Willdenow	26, 45
Oak, Turkey	*Quercus catesbaei* Michaux	62, 63, *64*, 65, 72
Oak, Water	*Quercus nigra* Linnaeus *Quercus obtusa* Ashe	69, 71, 72, 73, *76*, 78, 80, 81, 82, 83, 86, 89, 94
Oak, White	*Quercus alba* Linnaeus	2, 3, 7, 9, 10, 11, 14, 30, 31, 32, 33, 34, 35, 36, 38, 39, 40, *41*, 42, 43, 44, 45, 46, 48, *49*, *50*, 51, 54, *55*, 56, 57, 71, *80*, 81

Common name	Botanical name	Type numbers[1]
Oak, Willow	*Quercus phellos* Linnaeus	71, *76*, 81, 82, *83*, *84*, 86, 89
Palm, Thatch	*Thrinax floridana* Sargent	74, 96
Palmetto, Cabbage	*Sabal palmetto* (Walter) Roemer and Schultes	66, *67*, 74, *75*, 96, 97
Persimmon	*Diospyros virginiana* Linnaeus	64, 65, 68, 70, 89
Pine, Jack	*Pinus banksiana* Lambert	*1*, 2, 3, 20
Pine, Loblolly	*Pinus taeda* Linnaeus	44, 63, *68*, *69*, *70*, *71*, *72*, 73, 74, 75, 77, 91
Pine, Longleaf	*Pinus palustris* Miller	38, *63*, *64*, 70, *73*
Pine, Mountain	*Pinus pungens* Lambert	37, 40, 42, 43
Pine, Norway	*Pinus resinosa* Solander	1, *3*, 9
Pine, Pitch	*Pinus rigida* Miller	3, 9, 33, 35, 36, *37*, 38, 40, 42, 43, 44, 48, 90
Pine, Pond	*Pinus rigida serotina* (Michaux) Loudon	69, 74, 75, 90, *91*, 92
Pine, Sand	*Pinus clausa* (Engelmann) Sargent	*62*, 73
Pine, Shortleaf	*Pinus echinata* Miller	9, 30, 31, 34, 35, 36, *38*, *39*, *40*, *41*, *42*, 43, 44, 46, 48, *68*, 70
Pine, Slash	*Pinus caribaea* Morelet	63, *72*, *73*, *74*, *75*, 90, 91, *92*, 93
Pine, Spruce	*Pinus glabra* Walter	90
Pine, Virginia	*Pinus virginiana* Miller	30, 34, 36, 38, 39, 40, *42*, *43*, *44*, 56
Pine, White	*Pinus strobus* Linnaeus	3, 6, 7, *8*, *9*, *10*, 11, 12, 13, 14, 20, 21, 24, 26, 35, 36, *48*
Planer Tree	*Planera aquatica* (Walter) Gmelin	94
Plum, Pigeon	*Coccolobis laurifolia* Jacquin	96
Plum, Wild	*Prunus americana* Marshall	29
Poplar, Balsam	*Populus balsamifera* Linnaeus	1, 3, 4, 26
Poplar, Yellow	*Liriodendron tulipifera* Linnaeus	9, 10, 48, 49, 50, 52, *53*, *54*, *55*, 56, 58, 69, 72, 77, 79
Privet, Swamp	*Forestiera acuminata* (Michaux) Poiret	88
Sassafras	*Sassafras variifolium* (Salisbury) Kuntze	35
Seagrape	*Coccolobis uvifera* (Linnaeus) Jacquin	97
Sourwood	*Oxydendrum arboreum* (Linnaeus) de Candolle	31, 33, 36
Spruce, Black	*Picea mariana* (Miller) Britton, Sterns and Poggenberg	1, 21, 22, *23*, 24, 25, 26
Spruce, Red	*Picea rubra* Link	4, 6, 9, 10, 11, 12, *16*, *17*, *18*, *19*, *20*, 22
Spruce, White	*Picea glauca* (Moench) Voss	1, 16, *21*
Stopper	*Eugenia* Linnaeus	74, 96
Sugarberry	*Celtis laevigata* Willdenow	80, 82, *85*, 87
Sycamore	*Platanus occidentalis* Linnaeus	25, 59, 61
Tamarack	*Larix laricina* (Du Roi) Koch	22, 23, 24, *25*, 26
Titi	*Cliftonia monophylla* (La Marck) Sargent	90, 92, 93
Tupelo, Gum	*Nyssa aquatica* Linnaeus	69, 72, 73, 74, 94, 95
Walnut, Black	*Juglans nigra* Linnaeus	49
Willow	*Salix* Linnaeus	*88*
Willow, Black	*Salix nigra* Marshall	59, 88, 93
Willow, Peachleaf	*Salix amygdaloides* Andersson	61
Willow, Sandbar	*Salix longifolia* Muehlenberg	61
Yaupon	*Ilex vomitoria* Aiton	30, 92, 93
Yellow Poplar	*Liriodendron tulipifera* Linnaeus	9, 10, 48, 49, 50, 52, *53*, *54*, *55*, 56, 58, 69, 72, 77, 79

[1]Where type number is shown in italics the species occurs in the type name, otherwise only in the description.

Forest Type Index

Includes the types listed in the classification, all those mentioned in the type descriptions under "variants and synonyms" and some other type names recognized in literature and local usage.

Undoubtedly there are other type names which should be added to this index in order to make it more nearly complete. As here given the index includes 295 type names. Since only 97 of these names are accepted in the list of cover types of the Eastern United States the work of the Committee in correlating and condensing types is evident.

Forest Type Index

*A term originally used in the Southern Appalachians by the U. S. Forest Service. More properly a site designation rather than a type name. Somewhat more inclusive than "Cove-Hardwood," which see.

†Recognized by the Southern Appalachian Section Type Committee, Jour. Forestry 24 (1926) 677, but now split up and included under types 50 to 57 inclusive.

Type	Find under type number
Jack Oak	2
Jack Oak—White Oak	2
Jack Pine	1
Jack Pine—Oak	1
Jack Pine—White Birch	1
Juniper Glade	90
Live Oak	78
Live Oak—Cabbage Palmetto	66, 67
Live Oak Hammock	67
Loblolly Pine	69
Loblolly Pine—Shortleaf Pine	68
Loblolly Pine—Slash Pine	72
Loblolly Pine—Southern Red Oak	70
Loblolly Pine—White Oak	71
Longleaf Pine	63
Longleaf Pine Flatwoods	63
Longleaf Pine Sand Hills	64
Longleaf Pine—Slash Pine	73
Longleaf Pine—Turkey Oak	64
Lower Slope‡	
Mahogany	96
Mangrove	97
Mangrove Swamp	97
Maple—Beech	12
Maple—Beech—Hemlock—Yellow Birch	12
Maple—Hemlock	11
Maple—White Pine	13
Marly Flatwoods	75
Mesquite	27
Mixed Hardwoods§	13, 49
Mixed (Northern) Softwoods¶	
Mixed Swamp	24, 25, 26
Mountain Cedar	28
Mountain Lin—Yellow Buckeye—White Ash	51
Mountain Oak	29, 33
Mountain Pine—Chestnut Oak—Black Oak	37
Northern Hardwoods	12
Northern Red Oak	52
Northern White Cedar	24
Norway Pine	3
Norway Pine—Jack Pine	3
Norway—White Pine	3
Oak—Chestnut	56
Oak—Elm	86

‡A term originally used by the U. S. Forest Service in the Southern Appalachians. More properly a site designation rather than a type name.

§In addition the name is used in various parts of the eastern United States for a variety of forest cover combinations. For example as used by the Southern Forest Experiment Station in the Forest Survey in the Flood-plains of the Mississippi Delta this term may include portions of types 80, 81, 83, 84, 85 and 86.

¶A local type of importance in northern Maine. Not readily placed under any of the listed types, being transitional between several of the northern forest coniferous types.

Type	Find under type number
Oak—Elm—Ash	86
Oak Flat	2
Oak Glade	76
Oak—Hickory	49, 80
Oak—Maple	49, 51
Oak Ridge	49
Oak Shinneries	29
Old Field Loblolly	69
Old Field Spruce	18
Overcup Oak—Pecan	89
Overcup Oak—Water Hickory	89
Palm Savanna	67
Palmetto Belt	75
Palmetto Flatwoods	73, 74
Palmetto—Live Oak Hammock	67
Paper Birch	6
Paper Birch—Aspen	6
Paper Birch—Balsam—Spruce	21
Paper Birch—Red Spruce—Balsam Fir	20
Pin Cherry	5
Pin Oak	58
Pine Barren Flats	73
Pine Barrens	63, 73
Pine—Hardwood	1, 8
Pine—Hardwood and Hemlock	10
Pine—Hemlock	10
Pine Meadows	73
Pine—Oak	71
Pine—Spruce	9
Pitch Pine	37
Pitch Pine—Chestnut Oak—Scarlet Oak	37
Pitch Pine—Mountain Pine	37
Plateau Oak	34
Pocosin Pine	91
Pocosin Pine and Bays	91
Pond Cypress	93
Pond Pine	91
Pond Pine Pocosins	91
Post Oak	30
Post Oak—Blackjack Oak	31
Post Oak—Yaupon	30
Red Cedar—Gray Birch	7, 46
Red Gum	82
Red Gum—Cherrybark Oak	81
Red Gum—Clay Flat Oaks	83
Red Gum—Cow Oak	81
Red Gum—Loamy Ridge Oaks	81
Red Gum—Nuttall's Oak—Willow Oak	83
Red Gum—Swamp Red Oak	81
Red Gum—Yellow Poplar	77
Red Oak	52
Red Oak—Basswood—White Ash	51
Red Spruce	18
Red Spruce—Southern Balsam Fir	19
Red Spruce—Sugar Maple—Beech	17
Ridge	33
River Birch—Sycamore	59
River Birch—Sycamore—Red Maple—Black Willow	59

Type	Find under type number
River-edge Hardwood	59
Rosemary Pine—Black Oak—White Hickory	38
Rosemary Pine—Blackjack Oak	38
Rosemary Pine—Post Oak	39
Sand Pine	62
Sand Ridge	65
Savanna Pine	91
Scarlet Oak—Black Oak	33
Scrub	62
Scrub Oak	2, 32, 35
Scrub Oak Ridge	65
Shin Oak	29
Shortleaf Pine	38
Shortleaf Pine Hills	68
Shortleaf Pine—Post Oak	39
Shortleaf Pine—Southern Red Oak —Scarlet Oak	40
Shortleaf Pine—Virginia Pine	42
Shortleaf Pine—White Oak	41
Silver Maple	60
Silver Maple—American Elm	60
Silver Maple—Ash—Basswood—Swamp White Oak	60
Silver Maple—Elm—Ash—Hickory	60
Slash Pine	74
Slash Pine Bogs and Bays	74
Slash Pine—Swamp Black Gum	92
Southern Cypress	94
Southern Cypress—Hardwood	87
Southern Cypress—Tupelo Gum	94, 95
Southern Red Cedar	66
Southern Red Oak—Scarlet Oak	34
Southern White Cedar	90
Spruce and Hardwoods	17
Spruce—Balsam	21
Spruce Bog	23
Spruce—Fir	19
Spruce Flat	18
Spruce—Hemlock	18
Spruce—Pine	62, 91
Spruce Slope	18
Spruce Swamp	23
Sugar Maple	14
Sugar Maple—Basswood	13
Sugar Maple—Basswood—Elm	13
Sugar Maple—Beech	57
Sugar Maple—Beech—Birch—White Pine—Hemlock	10
Sugar Maple—Beech—Yellow Birch	12
Sugarberry—Elm	85
Sweet Bay—Swamp Black Gum	95

Type	Find under type number
Sycamore	59
Tamarack	25
Tamarack—Aspen	25
Tamarack—Aspen—Red Maple	25
Tamarack—Black Spruce—Cedar	25
Tamarack—Cedar	25
Tamarack—Cedar—Spruce	25
Tamarack—Spruce	25
Transition Hardwoods	51
Tropical Hammock	96
Tupelo Gum	95
Turkey Oak	65
Upland Hardwoods	79
Upper Slope	33
Virginia Pine	44
Virginia Pine—Chestnut Oak—Chestnut	44
Virginia Pine—Southern Red Oak	43
Water Oak—Willow Oak	76
White Pine	9
White Pine—Balsam—Hemlock	9
White Pine—Chestnut Oak	48
White Pine—Hemlock	10
White Pine—Norway Pine	9
White Pine—Red Oak—White Ash	8
White Oak	50
White Oak—Black Oak	49, 50
White Oak—Black Oak—Red Oak	49
White Spruce	21
White Spruce—Balsam Fir—Paper Birch	21
Willow	88
Willow Oak	84
Willow Oak—Cedar Elm	86
Willow—Poplar	61, 88
Yellow Birch	15, 16
Yellow Birch—Red Spruce	16
Yellow Buckeye—Sugar Maple—Yellow Birch	12
Yellow Poplar	53
Yellow Poplar—Chestnut	55
Yellow Poplar—Chestnut—Red Oak—Hemlock	55
Yellow Poplar—Hemlock	54
Yellow Poplar—White Oak	55
Yellow Poplar—White Oak—Black Gum—Red Maple	55
Yellow Poplar—White Oak—Black Oak—Mockernut Hickory	55
Yellow Poplar—White Oak—Red Oak	55
Yellow Poplar—White Oak—Sugar Maple	55

EDITOR'S NOTE: Copies of this report are available at the Society's Office, 810 Hill Bldg., Washington, D. C., for 50 cents a copy.

BRIEFER ARTICLES AND NOTES

What Price Forestry on Marginal Lands?

Editor, Journal of Forestry,

Dear Sir:

I find myself largely in agreement with your position[1] with respect to utilization of marginal land. I prefer to look at the problem which it raises from the standpoint of the most economical way of utilizing it. I have no doubt that for some of it this will consist merely in leaving it absolutely alone. The amount that would have to be spent upon it in order to get any larger product out of it is too great even from an ordinary long-time point of view. I am hoping, however, that economical methods, ordinarily of the very extensive type, can be developed for getting some net product out of the land when devoted either to grazing or forestry. I think that getting the land into some kind of grazing should be considered as an alternative to forestry in more cases than at present. The foresters have an important contribution to make in developing very extensive systems of forestry that still repay the little which is expended upon them. There will be occasions when the interests in the future demand a net loss for the present. This will particularly be the case for land which is highly subject to erosion.

Yours very truly,

J. D. Black,

Chairman, Advisory Committee on Social and Economic Research in Agriculture, Social Science Research Council.

Notes on Black Locust

The Central States Forest Experiment Station is vigorously pursuing a study of black locust and reports several interesting observations.

Some of the tallest stands of planted locust which have yet been found occur in Jefferson County, Indiana, according to Leonard F. Kellogg, in charge of the silvicultural studies. An excellent stand at Paris averaged 80 feet in height at forty years of age. Trees within the stand ranged up to 13 inches in diameter at breast height, and one tree on the outside edge of the stand measured 20 inches. Another good stand, planted thirty-one years ago on limestone soils southwest of Dupont, ranges up to 75 feet in height and up to 15 inches D.B.H. In Morrow County, Ohio, Mr. W. L. Stevens has produced fine straight trees 84 feet in height and 12 to 13 inches in diameter in thirty-nine years by planting locust in openings in his ungrazed beech-maple woodlot.

The thrift and abundance of locust sprout growth appear to be somewhat correlated with glaciation in Ohio. Several members of the field parties have noticed the great variation in the occurrence and vigor of black locust sprout generation. Sprouts are most numerous in the unglaciated districts along the Ohio River, or in the areas of old Illinoian glaciation. Where the more recent Wisconsin Drift Sheets are found, to the north and west, it is observed that sprouting is much less vigorous and

[1]As expressed in a letter paralleling contents of editorial "Diluting the Forestry Effort" in the April 1931 issue.—*Editor.*

less frequent. In places the transition is very marked.

The relationship existing between grazed woodlands, soil litter and nitrogen-fixing nodules on the roots of black locust, were quite definitely determined. Field parties observed that, in almost all cases where abundant nodules were found on locust roots, the plantations were ungrazed and the soil was loose and porous. Where heavy animals packed the soil and destroyed the light leaf litter, very few nodules were found. They appear to form most frequently at the surface of the mineral soil in stands where duff and litter are well developed.

Soil acidity apparently is not a major factor in the nitrogen-fixing role of black locust. Early in the season Dr. J. T. Auten and Dr. R. C. Hall decided that soil acidity apparently had no material influence on the development of nodules. Chapman concluded, after carefully observing this feature on various soils throughout Ohio, that these preliminary observations were correct. On glacial limestone soils, those derived from sandstone and shale, and on residual soils of various degrees of acidity, no apparent difference has been observed in nodule development, on sites which were more approximately comparable except possibly in origin of soil and its acidity.

Extraordinary height growth for a black locust seedling is reported by the State Forest Nursery at Anna, Ill. At the end of the first season's growth this seedling measured 11.5 feet in height and 0.7 inch d.b.h.

Strange Conversions of Types

There are two examples of the conversions of types on the Chippewa National Forest which are very interesting and, I believe, quite unusual. Perhaps I am going too far in the above statement for while one conversion has practically completely taken place, the other is only in the process of taking place.

On the western half of the Cut Foot District the government made a timber sale including the whole area. The stumpage is made up of approximately four-fifths aspen. Incidentally it is the largest sale of aspen that has ever been made.

The area contains large bodies of aspen averaging 60 years of age. The stands on the whole are made up of large, tall trees with a good stand per acre. The soil varies from rich sand to clay with a mixture of the two predominating.

As nearly as we can tell from the General Land Office records, the whole area was swept by a very bad fire approximately 65 years ago. As we go through the stands of aspen now we find on slight rises of ground an occasional white pine stub or stump of very large size. Occasionally we find the remains of a white oak. But strange as it may seem, we find in many places thick masses of cedar windfalls of large size. Many of these windfalls are still, after 60 years more or less, in fairly sound condition. At least they are sound enough to permit their use in many cases by the loggers for firewood.

Obviously the majority of the areas now covered by stands of aspen were once cedar swamps. All through the area we find the outlines of small streambeds which have probably carried no water since at least before the fire.

Apparently the cedar swamps were drying out and were fairly dry when the fire swept through them. Otherwise it would not seem probable that any fire could gain enough momentum to sweep through such a large area of swampland. Where the aspen seeded in from so densely is a mystery but there it is and where once we had wonderful

cedar swamps we now have wonderful stands of aspen.

The other example of conversion in progress, while not so conclusive, is just as interesting. The area is a typical muskeg with Labordor tea, etc. Around the edge is a typical black spruce swamp right where it belongs. The spruce is seeding out into the swamp just as it should. All age classes are represented from old to young going from the outside edges out into the center where the bare muskeg is found. But there, mixed in with the spruce reproduction, and quite thick, is jack pine reproduction. It appears to be very healthy although it is not making the growth of jack pine on uplands. It averages 10-15 years in age and apparently is there to stay.

What will happen? Will the jack pine beat out the black spruce or vice versa? So far they are about equal in growth. If the jack pine takes over the muskeg it certainly will be a strange conversion.

GERALD S. HORTON,
Chippewa National Forest.

A Bark Blazer for Marking Trees

It is often desirable in sample plot work to mark the trees in some temporary fashion so that no trees will be missed entirely or measured more than once. For this purpose, yellow marking crayon is satisfactory if the trees have smooth, dry bark, but the crayon is not satisfactory for use on rough bark or when the bark is wet.

The device described here is used to "check" the trees as they are measured by scraping one or more broad lines in the bark. This tool resembles the ordinary timber scribe, but makes a very much wider mark. It was first made by the writer in 1924, and has been used by a number of others since that time with complete satisfaction. This note is issued in response to requests which have come concerning the design of the tool.

This bark blazer consists of a piece of three-eights-inch spring steel rod bent to form an oval handle with the one projecting end turned back and flattened into a blade about one and three-fourths inches wide. The total length of the tool is about four and one-half inches. The attached drawing indicates the size and shape of the blazer. (The handle ordinarily is wound with tape to improve the holding qualities.) Any blacksmith can make one of these blazers at a cost of a few cents.

Aside from the advantages over crayon in being adapted to wet bark and to very rough, flaky bark, this blazer makes a mark large enough to be seen from a considerable distance and eliminates the expense and bother involved in the replacement of crayons.

RICHARD E. MCARDLE,
Pac. N. W. Forest Exp. Sta.

The Future of Aspen in the Lake States

The enormous acreage of aspen in the Lake States (some 22 million acres), its small utilization, its universal decadence and short life, make many people look with justified doubt upon aspen as a crop of economic importance. The possibilities of converting aspen by artificial means to pine and spruce are seriously discussed. In this discussion the tendency toward natural conversion of aspen to other types, particularly hardwoods, is often overlooked.

The forest surveys conducted by the Lake States Forest Experiment Station in Wisconsin, Michigan, and Minnesota, covering more than one million acres of aspen land, throw some interesting light

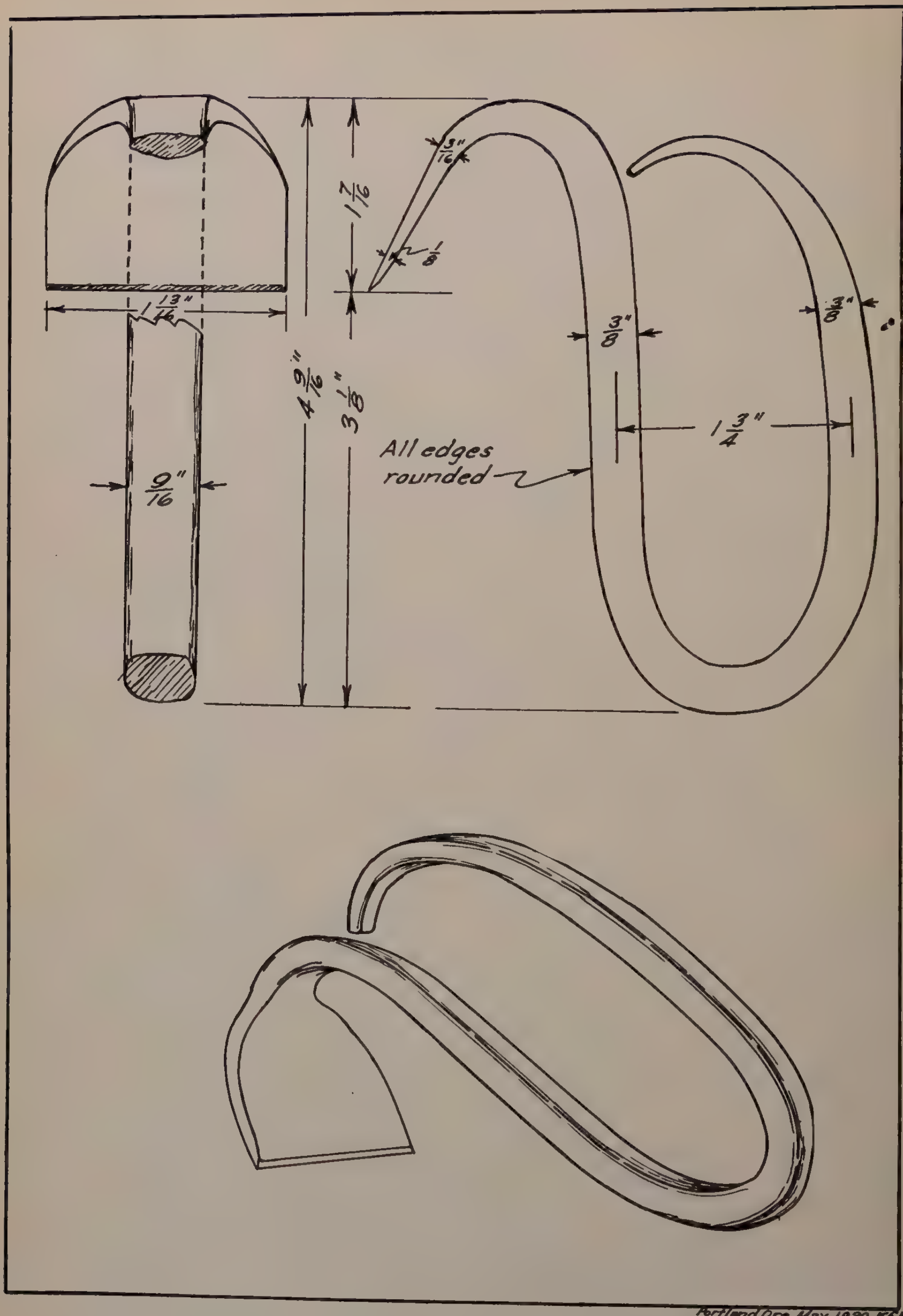

FIG. 1—A bark blazer for marking trees.

upon the present composition of the aspen stands and, hence, their probable future. Some results of this survey are given in the Station's Technical Note 50.

To begin with, there are few aspen stands that are 100 per cent pure. Most of the "pure" aspen stands contain only from 50 to 65 per cent aspen and many stands classed as aspen contain as little as 30 per cent of that species. This refers to trees one inch or over in diameter. The other species in mixture are either inferior hardwoods (paper birch, red maple, jack oak, ironwood and black ash), which make up from 10 to 30 per cent of the stand or the better hardwoods (sugar maple, yellow birch, basswood, red and white oak, white ash, and elm). These, too, may form from 10 to 30 per cent of the entire stand. And finally conifers (jack, white and Norway pines, balsam, spruce and, in some places, hemlock) that may comprise from 4 to 10 per cent of the total stand.

Since all these species are much longer lived trees than aspen, they will eventually, if not disturbed by fire, take the place of the aspen.

The character of reproduction, that is, trees below one inch in diameter, may serve as an indication of the future composition of the aspen stands. The striking fact is that most of the seedling reproduction in aspen stands is not aspen. On loamy soils, in Wisconsin, over 50 per cent of the entire reproduction was found to be of hardwoods, principally sugar maple with some small amount of white pine and spruce. On the sandy soils, the better hardwoods may form only one-fifth of the entire reproduction, but the inferior hardwoods are quite prevalent and there is usually a sprinkling of jack pine or white pine, and in wet places balsam fir or spruce. This would indicate that, on the heavier soils, aspen is being changed naturally into other hardwoods and the change is relatively rapid. Considering that over millions of acres there may be found upwards of 200 trees per acre of better hardwoods in the present aspen stands, the conversion should be well advanced within the next 25 to 50 years. On the sandy soils, the conversion is toward jack, Norway and white pine and, in some places, balsam, but this process is slower than the conversion to hardwoods.

Fires or clear cutting of aspen on either sands or loams may throw it back into pure aspen.

If the aspen stands are left to nature and not disturbed by clear cutting or fires, they may, within another generation, present an entirely different silvicultural and economic aspect. The presence of a large number of better hardwoods in many of the aspen stands augurs well for their future.

Inaccuracy of Seedling Analysis in the Field

Recently a field party from the Allegheny Forest Experiment Station collected seedlings in a hardwood-pine-hemlock forest. The object was to determine the total age of each seedling, and the number of years required to reach heights of 1, 2, 3, 4, and 5 feet. The growth rings of most of the seedlings proved to be so close together as to raise doubts as to the accuracy of the field count. Thirty-six hemlock (*Tsuga canadensis* L. Carr.) and twenty-four white pine (*Pinus strobus* L.) suppressed seedlings were therefore re-anaylzed in the office. The office analyses were facilitated by the use of a traversing stage microscope loaned to the Station by the Pennsylvania State Forest School. The age of each section was counted at least twice, and the more difficult counts were repeated until all reasonable doubt as to accuracy was removed.

TABLE 1

ACCURACY OF FIELD COUNTS AS COMPARED WITH OFFICE COUNTS

	Hemlock			White pine		
Height	Per cent deviation	Standard deviation ±	Per cent of perfect field counts	Per cent deviation	Standard deviation ±	Per cent of perfect field counts
Ground	19.7	8.45	11.1	18.6	3.71	12.5
1-foot	21.3	4.42	2.8	17.6	2.27	25.0
2-foot	25.5	3.10	5.7	13.7	1.45	31.6
3-foot	32.3	2.90	13.8	16.3	1.08	22.2
4-foot	42.7	2.35	10.5	11.4	.89	40.0
5-foot	35.8	1.35	16.7	0	0	100.0

Standard deviations and percentage deviation of the field count from the office count were then computed, and are summarized in Table 1. Since no field count showed more rings than the corresponding office count, the deviations were all minus (based on office count). The column "per cent of perfect cases" in the tables refers to the percentage of field counts which were equal to the office counts.

It is evident that the standard deviation for both species was considerable, but decreased with increase in the height of the section. The decrease is explained by the fact that the rings in the upper sections are easier to count because they are not obscured by compression wood and as a rule are not so close together as those in the lower sections. Per cent deviation decreased with height of the section for white pine, but increased for hemlock. This is because a substantial percentage of the pine counts was correctly made in the field, particularly at the higher sections; perfect field counts of hemlock, however, were rare, and a miss of one or two years at the higher sections of few rings caused a large percentage deviation.

Field counts of the hardwood ages were so evidently unreliable that none were recorded. In office analyses various chemicals were tried for making the rings of the diffuse-porous hardwoods easier to count. A 10 per cent solution of ferric alum was found to be the best for red maple (*Acer rubrum* L.), and phloroglucin and hydrochloric acid treatment gave the best results with sweet birch (*Betula lenta* L.) and yellow birch (*B. lutea* Michx.). No treatment was found which gave better results for beech (*Fagus grandifolia* Ehrh.) than rubbing the moistened, smoothly cut end-surface with a fine-grained sandstone such as is used for sharpening knives. No chemical treatment was necessary for the white pine and hemlock sections.

H. F. MOREY,
Allegheny Forest Experiment Station.

TYPES AREAS IN SELECTED OREGON AND WASHINGTON COUNTIES

In connection with the forest survey of the Douglas fir region, a number of generalized type maps for several counties in Oregon and Washington have been prepared recently for use by the agricultural experiment station, who will assist in estimating the acreages likely to be withdrawn from forest areas for agricultural use within the next three decades. In Table 1 the board type areas of six selected counties are given, showing some interesting conditions and variations.

The dependence of some counties upon the forests for their economic existence is evident upon inspection of the table.

Clatsop and Columbia Counties in Oregon and Cowlitz and Wahkiakum Counties in Washington all show less than 20 per cent of their area at present converted to agricultural use; by far the greatest area is in some sort of forest cover. It is reasonable to assume that in these four counties future conversion of forest land to farm land will be of little consequence, and that the economic future of these counties is dependent upon the continued productivity of their forest areas. On the other hand, Benton County in Oregon and Clark County in Washington have nearly half their acreage already under cultivation or in pasturage. In these two counties the forest assumes therefore only a secondary economic role. (From Dec., 1931 *Research Notes*, Pacific Northwest Forest Experiment Station.)

R. W. Cowlin.

TABLE 1

TYPE AREAS IN ACRES FOR SIX OREGON AND WASHINGTON COUNTIES

	Oregon counties			Washington counties		
	Benton	Clatsop	Columbia	Clark	Cowlitz	Wahkiakum
Cultivated and pasture	206,618	30,992	84,400	238,303	85,599	17,395
Merchantable timber over 20″ d.b.h.	121,528	265,540	72,619	22,114	287,789	48,257
Second growth under 20″ d.b.h.	70,803	100,414	119,232	37,127	225,804	65,456
Deforested burn	17,613	3,697	1,862	67,230	17,710	632
Nonrestocking cut over		6,725	30,218	19,761	23,613	13,124
Cut over since 1920	17,481	95,802	99,735	13,471	73,792	19,668
Hardwood	1,277	7,187	14,555	2,637	5,165	6,143
Nonforest land[1]	5,000	15,083	1,059	9,617	18,448	205
Total	440,320	525,440	423,680	405,760	737,920	170,880

[1]Includes barrens, brush, swamps, cities, industrial sites, etc.

New Disease on White and Red Pine

A tree disease new to American forest pathologists and apparently caused by a fungus as yet unidentified is under investigation by Dr. Harlan H. York, investigator and consultant forest pathologist of the New York State Conservation Department. The disease attacks white and red pine and has made considerable headway in the plantations of the City of Rochester on Hemlock and Canadice lakes in southwestern Ontario County. It also exists in white pine plantations of the Norwich Cemetery Association at Norwich, where it was first noticed in 1928. About 40 acres of the Rochester plantations are affected by it.

The studies being made by Dr. York and his associates have not progressed far enough for complete determination of the cause of the disease, but the fact that it operates on the base of the tree trunk and on the portions of the roots close to the trunk has been definitely established.

A characteristic of the disease is a profuse exudation of resin at the base of the trunk which permeates the soil for several inches around each diseased tree still living. It is considered possible that the disease may spread from tree to tree through the ground, as infected trees were found closely surrounding trees killed by the disease which apparently had served as foci of infection. Twenty-one infected trees still living were found surrounding one such dead tree.

Theories that the trouble was caused by insect pests or by the fairly well-known "shoestring fungus" have been nullified by the investigation. No trace has been found of either. Series of cultures have been taken from the infected trees for miscroscopic study, and identification and

for this purpose various culture media are being tried. Experiments in means of combatting the disease will then be taken up.

Examination of the infected parts of the trees shows a characteristic mottling of the inner bark near the base of the trunk and an enlargement and breaking down of the resin pores in the same region and in the wood.

The character of the soil types in the two areas in which the disease has been found is dissimilar, pointing to the probability that the disease is caused by a fungus.

"If it should prove," said Dr. York, "to be a disease of foreign origin, its history may be found to be similar to that of other plant diseases introduced into this country from abroad, which have had a period of slow development of several years, followed by great activity when the fungus becomes adapted to its new environment."

The disease apparently requires about from three to five years to kill a tree after the attack has begun. The trees in which it is spreading in the Rochester plantation are of both white and red pine set out in 1910 and subsequent years and are thus of considerable size.

The Control of Hemlock Loopers By Airplane Dusting

The modern airplane has opened up many new possible uses in connection with forest work, one of which is the control of forest defoliators. In the past outbreaks of insects which strip forest trees of their foliage and kill extensive areas in a few tragic years have been allowed to run their course, because there was no practical means of dealing with them. The refined methods applicable to the control of park and shade tree insects have no place in commercial forestry. But the airplane, and the clouds of poisoned dust which it can liberate, gives us a new weapon to use in such emergencies.

The technique of airplane dusting was first developed for use with such field crops as cotton. Later it was adapted to forest purposes and has been tried in the eastern United States and Canada for the control of such leaf-eating pests as the gypsy moth, catalpa sphinx and hemlock looper. All of these projects have been essentially on an experimental basis, but they have shown every promise of success, even though the cost has usually been high (from $6.00 to $7.00 per acre).

During the past summer this method was used to control a serious outbreak of the hemlock looper in Pacific County, Washington, for the first time in the western United States. This project was by far the largest of its kind ever attempted, and the dusting of 5,400 acres placed it on a commercial scale. The project was financed largely by the State of Washington and the Weyerhaeuser Timber Company. The Northwest Air Service furnished a Ryan monoplane with 300 h. p. motor, equipped with a hopper capable of carrying 1,000 pounds of dust. A gate in the bottom of the hopper, operated by a lever in the cockpit, released the dust when desired, and two electrically driven "agitators" kept the dust in motion and assured a uniform feed. The beach at Ocean Park was used as a landing field, and here a loading platform and hopper was built which enabled the plane to be loaded in eight minutes. All of the mechanics of the operation were worked out in detail under the supervision of Mr. C. S. Cowan, of the Washington Forest Fire Association and Mr. T. S. Goodyear, Assistant State Supervisor of Forests. The operation at the loading end functioned perfectly.

Actual dusting operations started on July 3 and continued until July 16, when the entire 54 tons of dust had been spread. The rate of application was figured at 20 pounds per acre, and the dust laid down in

strips approximately 140 feet in width, with the plane flying not more than 40 feet above the tree tops. It was extremely hazardous work, but fortunately no accidents occurred. In order to secure satisfactory adhesion, it was necessary that the foliage be moist with dew. This required the dusting to be done in the early morning hours between 5.00 A. M. and 9.00 A. M. Wind in excess of 10 miles per hour, low humidity, fog or rain necessarily stopped the work. The total cost of the job was approximately $15,000, which averaged $2.75 per acre or about 9 cents per thousand board feet of timber dusted.

The results of the dusting were determined through studies made by the Office of Forest Insect Investigations. Check plots, consisting of muslin frames of 10 square feet each, were distributed through the forest and records kept before and after dusting. The daily caterpillar droppings indicated the rate of mortality and showed the results of the work. The effect of the dusting was also indicated by the number of dead caterpillars found on the frames. The plots in the path of the dust clouds showed the effects within one day, and the greatest mortality occurred during the second and third days. The average of seven dusted plots as compared with ten undusted ones showed a reduction of 70 per cent at the end of the first week. At the end of the season the dusted areas showed a noticeable difference from undusted areas in the amount of foliage retained.

The greatest difficulty was in securing a uniform coverage. Without flight markers, which it was found impractical to erect, it was impossible to lay down the dust clouds in parallel and overlapping strips, and so the resulting kill was somewhat spotty. It was also found that the dosage used satisfactorily in eastern forests was somewhat low for the tall trees and dense stands of the Pacific Northwest. The tops of the trees absorbed all of the dust, and very little sifted through to the lower branches. This resulted in saving the tops of the trees, the most important part, while the lower foliage was often completely stripped. Then, too, portions of the area were of such rough topography that releasing the dust at anything less than 100 feet from the tree tops was quite out of the question. So parts of the area had to be abandoned to the loopers.

The main objective of this dusting project was to break up the concentrated infestation which threatened to completely defoliate and kill large patches of timber. The halting of the epidemic or the prevention of its spread to other areas was not considered as being practical, since it was discovered that some 32,000 acres were more or less infested. All that could be looked for was a saving of the more valuable stands until the epidemic passed over and was ultimately brought under control by natural factors. If a complete stripping of the trees could be prevented and 50 per cent of the foliage retained, the trees would recover. A complete defoliation, even for one year, was known to be fatal. This purpose of the dusting project was to a large degree satisfactorily accomplished, and much of the timber north of the Naselle River that would have been killed this year has been saved. Now the indications are that the looper outbreak is rapidly declining and possibly is already at an end. We shall all hope so, for the toll taken in past outbreaks has often passed the half billion board foot mark, and such a loss is one that the timber owners can ill afford to take at the present time. (From Dec., 1931, *Research Notes*, Pacific Northwest Forest Experiment Station.)

F. P. Keen.

Growth Cycles In the Western Yellow Pine Region of Oregon and Washington

Interesting evidence has been given by various investigators, both European and

American, to indicate that the rate of growth of trees, especially upon a so-called "sensitive site," is intimately related to the variation in the amount and seasonal distribution of precipitation. In this opinion we also concur, although maintaining that many other factors may be present which affect the growth rates of single trees. An investigation, therefore, which will give a satisfactory solution to the problem of fluctuating growth of stands as a whole must be based upon sufficient material. During the past year a study was started in connection with the growth and yield investigation of western yellow pine in an attempt to determine whether or not growth rates over extensive areas have periods of good growth and periods of poor growth. Sixteen locations in Oregon and seven in Washington were picked as being fairly representative of the region, and in each of these 23 areas, about 10 mature trees were chosen, bored, and the cores measured ring by ring back to the center of the trees. Some of the records extend back for 400 years.

PERIODS OF GOOD AND POOR GROWTH IN VIRGIN WESTERN YELLOW PINE STANDS OF EASTERN OREGON AND WASHINGTON

Period	Character of Growth	No. of Years
1930-1917	Poor	14
1916-1904	Good	13
1903-1898	Poor	6
1897-1895	Good	3
1894-1886	Poor	9
1885-1876	Good	10
1875-1870	Poor	6
1869-1853	Good	17
1852-1842	Poor	11
1841-1836	Good	6
1835-1827	Poor	9
1826-1811	Good	16
1810-1795	Poor	16
1794-1777	Indeterminate	18
1776-1763	Good	14
1762-1755	Poor	8
1754-1745	Good	10
1744-1735	Poor	10
1734-1727	Good	8
1726-1718	Poor	9
1717-1713	Good	5
1712-1708	Poor	5
1707-1700	Good	8

Summary	Average Length	Range in Years
Periods of good growth	10.0	3-16
Periods of poor growth	9.3	5-16

In brief the tentative results of this study show a pronounced wave-like progression in growth. It is possible to establish the following periods as being approximate dates of good and poor growth over the general region east of the Cascades in Oregon and Washington.

Practically all the short flares in growth are omitted from consideration in this table; they may occur at any time differently for almost every area. The average length of the periods shown in the table summary is affected somewhat by a multiplicity of cycles which can easily shorten or lengthen the individual periods by a number of years. The sum of the two average periods, 19.3 years, is a cycle probably closely connected with one varying between 21 and 24 years, but whose exact length has not yet been determined. Further intensive study is being made on this subject. (From Dec., 1931, *Research Notes*, Pacific Northwest Forest Experiment Station).

WALTER H. MEYER.

HELPING NATURE TO SEED THE FOREST

In this age when reduction in the cost of production is diligently searched for in every direction, foresters must also seek to develop cheaper methods of timber growing. The universally accepted procedure of replacing an old forest with a new one is by planting.

During last summer, the Lake States Forest Experiment Station attempted to assist nature in reëstablishing a forest by the use of an ordinary farm disk harrow. One area selected for this experiment proved very successful. The results of the experiment are reported in the Station's Technical Note No. 45.

A 3-acre plot was selected on the Chippewa National Forest in an old Norway pine stand. The ground was practically devoid of any young trees. This plot was disked in the autumn of 1930 at the time the seeds were falling. A year later, in the fall of 1931, an examination was made of the disked and the adjoining undisked areas. On the disked area over 15,000 1-year old seedlings per acre were present, while on the adjoining undisked area only 2,000 seedlings.

To prove that the abundant reproduction is due to disking, the seed was sown at staked spots on the disked and undisked soil. One year later, on the disked soil, there was one seedling for every 35 seeds sown and on the undisturbed soil one seedling for every 50 seeds sown. Apparently about 97 per cent of the seed failed to germinate from one or another cause. On the disked soil there was one dead seedling in every five, while on the undisked soil there was one dead seedling in every two. Disking improved the chances of survival.

The disk, by cutting up the sod and shrubs in the ground, lessened the competition of the under-growth and helped the seedlings to survive the dry summer. The seedlings on the disked soil were found most numerous in the bottom of the narrow furrows made by the disk. Evidently the furrows provided not only better conditions for germination and survival but also protected the seed from birds and rodents. The cost of this method of seeding the ground is estimated at about 75 cents per acre. As contrasted with from $6 to $10 for planting, the method has a distinct practical advantage wherever it can be used effectively.

Is Light Important Immediately after Germination?

It is generally assumed that the growth of seedlings during the period they are drawing their nourishment from the food stored in the seed is independent of light. It was thought that it is only later in life, when the stored food is exhausted, that the plant becomes entirely dependent upon food manufactured by its own green leaves under the influence of light.

Recent experiments conducted by the Station indicate that sunlight is an important factor in the life of the young plants long before its food stored in the seed is exhausted. If this proves to be generally true, then it may modify to some extent our forest nursery practice, explain the more rapid growth of young seedlings in openings, and enable us to understand better the needs of the seedlings in their early life.

Although the experiments were conducted in the greenhouse and laboratory with seed of common corn, the results are probably equally applicable to all other plants, including forest trees. Corn seed germinated in weak light and corn seed germinated in full sunlight showed a marked difference in their behavior. The seedlings which came up in full light utilized the stored food and grew far more rapidly than those in subdued light. When, however, the seedlings were grown in different light intensities but at the *same temperature*, no difference in either growth or the rate of utilization of the stored food material was detected.

The natural conclusion seems to be that it is not light as such that causes this stimulation in growth but the higher temperature that invariably accompanies stronger light.

Sunlight, through its action in warming the air and soil, tends to hasten the utilization of the kernel and the ultimate shedding of the seed coat, after which the seedling is comparatively free from danger of destruction by birds, mammals, and probably even damping off.

Since the more critical period in the life of a tree seedling is from germination until the seed coat is shed, the more rapidly the seedling can pass through this period the greater are its chances for survival.

(Tech. Note 46, Lake States Forest Experiment Station.)

Southern Piners Seek Methods to Improve Lumber

Plans are being laid for the exhibition of new devices, methods and practices that would serve to strengthen the Southern Pine industry at the annual meeting of the Southern Pine Association, to be held in New Orleans the latter part of March, according to an announcement made by H. C. Berckes, Secretary-Manager.

"If there is one thing that the future points to with certainty," said Mr. Berckes, "it is the requirement that lumber shall have to be refashioned and refined and chemically treated to preserve its appearance, strengthen its resistance against decay, and make it impervious to fire. Our committees are now studying closely our grading rules, with a view toward their revision to meet the requirements of present and future markets. We feel that the attention of our industry should be concentrated upon the potentialities of its product, and so we have decided to devote a session to the consideration of every idea that would contribute toward the improvement and diversification of the products which have always come from our sawmills, the development of new processes, and the broadening of general understanding as to the unlimited opportunities which have always lain dormant in our industry."

Mr. Berckes indicated that the lumber industry must awaken to the fact that its competitors are spending millions of dollars each year in industrial and market research. There is not a successful industry today, he said, functioning along the exact lines that it followed five years ago, and yet the lumber industry, by and large, is operated exactly as it was in the beginning of the twentieth century.

Continuing, Mr. Berckes stated that "processes have been evolved for the treatment of lumber to make it fire-resistant and decay-proof, for its fabrication at the mills to meet particular industrial uses, and for the development of by-products, but no organized thought has been given to the practical application of these ideas. Southern Pine lumber is better adapted to treatment and fabrication than almost any other softwood species. Its by-products possibilities are almost unlimited. Its rapid growth will doubtless make the South the country's source of permanent timber supply, and the time has come when the industry must do something about it."

Ponderosa Pine Now Official

Western yellow pine will hereafter be known as ponderosa pine, according to a report from the Forest Service. The technical name of this species is *Pinus ponderosa* and the official common or English name has heretofore been western yellow pine.

This change of name was recommended by the nomenclature committee of the U. S. Forest Service and was approved by the regional foresters, the forest experiment stations and later by the chief forester. This name, ponderosa pine, will be used henceforth by the Forest Service and will designate the wood of the *Pinus ponderosa* and of Jeffrey pine which is of the same family.

REVIEWS

Edited by Dr. Henry Schmitz, University of Minnesota, St. Paul, Minn.

The Physical Properties of the Cove Soils on the Black Rock Forest. By Harold F. Scholz. *Black Rock Forest Bul. No. 2, 59 pages. 1931. Cornwall-on-the-Hudson, N. Y.*

A forester reaches eagerly for a new bulletin with a title like this one, to see if somebody has found an answer to the question of whether or not soils are important in forestry. Mr. Scholz, is a graduate student at the Harvard Forest School, completed a coöperative study on the Black Rock Forest which lies some 50 miles north of New York City. It will be recalled that Bulletin No. 1 of this series, appeared in 1930 and is a very finished description of "The Black Rock Forest," by H. H. Tyron. This bulletin (No. 2) is also a well gotten up publication.

But it is interesting to note what Mr. Scholz has singled out as being a measure of the soils' physical properties; namely, texture measured by mechanical analysis. He dug 137 holes to observe the soil profile and gathered the following data at each:

1. Depth and physical condition of litter, duff and humus.
2. Depth, structure, color, texture, and consistency of the mineral horizons.
3. Moisture conditions of the soil.
4. Altitude, slope and exposure.
5. Soil samples for analysis at depth in inches of 2.5, 5, 9, and 19.
6. Zone of tree root concentration—average and greatest depth.

Scholz states that agriculturists are interested chiefly in the surface 8 inches of soil because this is the part plowed and holds most of the annual crop roots. So he investigated the zone of concentration of the roots of the hardwood forest in the area under consideration to determine how deep he should study the soil and found that the tree roots rarely went below 18 inches, most of them being in the surface 11 inches. (The soil is a mantle of glacial till on bed rock, with many rocky outcrops.) He then proceeded to sample each profile dug, at roughly the following depths: 2.5, 5, 9, and 19 inches. By making a mechanical analysis at each of these depths, he found that the soils on the Black Rock Forest were very much the same texture from the surface down to 19 inches. When he used the sample at the 5-inch level (which is the middle of the 11-inch surface horizon) as indicative of the entire 19-inch profile, there was an error of only about 5 per cent in the texture determination. This fact he points out is of importance only to the Black Rock Forest, for soils in other parts of the country may vary greatly in texture at different depths.

Texture. On the Black Rock Forest were found soils of four textural classes:

1. Clay.
2. Clay-loam. (a) With clay content from 25 to 30 per cent. (b) With clay content from 20 to 25 per cent.
3. Loam.
4. Silty clay-loam.

The clay-loam texture covered 5 times as much area as the other three textures combined.

Soil structure (*tilth*). At from 10 to 20-inch depth the soil was very compact in about half the profiles dug. Yet the mechanical analysis did not show any in-

crease in clay as a possible cause of the compact zone. Scholz is unable to explain this compaction. He does not make a single volume weight determination to measure the apparent density of the soils he is studying. We are left to judge the structure from such data as: "This compact part of the profile can only be excavated easily with a mattock and in some cases the compactness becomes so great that even mattock excavation is done with difficulty." Such measurements of the physical properties of a soil are crude.

Rock content. The soil on the Black Rock Forest is very stony. Scholz measured the rock content by classing all stones 4.5 inches in diameter down to 2 millimeters in size as "gravel," and, by sieving, found 31 per cent of the oven-dry weight of the soil to be "gravel" (17 to 52 per cent range). Such a large amount of rock on the Forest caused the federal soil survey men to class the land as "rough stony land and rock outcrop" when they mapped it some years before.

Soil moisture. Foresters are fairly well agreed that site in the forest is strongly controlled by soil moisture. So one comes to the discussion of soil moisture with considerable interest. Scholz found by observation that the soil was moist in the cove bottoms and on lower slopes while on the steep upper slopes and high ridge tops the soil was drier. Such observations certainly do prove that water will run down hill.

One wonders what sort of conception the author has of soil and water when he next states: "In the opinion of the writer, the texture of the soils of the Black Rock area exert an influence upon the moisture conditions of the profile." Such a guarded statement of one of the fundamentals of soil physics is annoying. It should be called to Scholz's attention that a determination of the moisture equivalent of the various soil profiles would not only have made clearer to him the closeness of the relationship that exists between soil texture and moisture conditions of the profile, but would have added a very important measurement to this study of the physical properties of the soil.

The moisture conditions of the profiles were classified by observation while in the field into 3 groups: wet, moist and dry. If it rained during the study, might not a soil classed as dry on the day before a rain go into the moist group on the day after? Before there is any value is knowing that 10 per cent of the profiles were classified as wet, one must know how wet is "wet" and is it as wet as that all year!

Humus content. Some interesting determinations were made on the organic content of the soil, using Robinson's peroxidation method and also the method of loss on ignition. No correlation could be found between depth and condition of the litter and duff layers and the organic content of the soil below. All of the four textural classes had about the same humus content, with just a trifle more in the clays (2 per cent and less).

Scholz shows that he has profited by his training at the Lake States Forest Experiment Station in that he avoided the lure of an easy an inaccurate method of mechanical analysis which has already vitiated the researches of some foresters. Before starting his mechanical analysis he made a comparative study of a very quick method (Bouyoucos hydrometer) versus the standard pipette method. In the appendix is given a description of the methods tried, the results of comparing the two methods (in which the easy method was found too inaccurate), and tables giving all the data. The bulletin represents a large amount of work and any criticism that may be made of it results directly from there having been too few such studies made as yet on forest areas.

JAMES L. AVERELL,
University of California.

Die Kohlenstoffernährung des Waldes. (Carbon Nutrition of the Forest). By Dr. Th. Meinecke. *J. Springer, Berlin, 176 Pp. 1927.*

According to the author, the element carbon forms about 50 per cent of the dry weight of both conifers and hardwoods. Its source is carbon dioxide which is combined chemically with water by photosynthesis to form the very substance of which a plant is composed. It is obvious, therefore, that carbon dioxide relationships warrant careful study on the part of forest research workers.

In his book, Meinecke discusses the role of carbon dioxide in the forest. He takes up the various theories concerning carbon nutrition and their bases, important discoveries in this field by himself and other investigators, and the application of these facts to forestry. A considerable portion of the treatise is given over to an explanation of the technique and instruments used in experiments conducted on soil respiration. Factors affecting the rate of carbon dioxide production are covered thoroughly.

The author points out that an increase in the amount of available carbon dioxide can produce a considerable acceleration in growth because the rate of assimilation in a living plant is closely dependent upon the availability of this chemical compound. Its major sources in the soil are: (1) chemical reactions which occur deep down under the surface of the earth; (2) root respiration; (3) action of such micro-organisms as bacteria, molds, and algae which decompose organic matter. The forester has some control over the last two factors. For instance, he can control and modify conditions in a stand so as to provide more favorable conditions for the increased growth and activity of carbon dioxide-producing organisms in the soil.

Temperature is the most important factor affecting their activity. Soil temperature is more important than air temperature. The opening up of the crowns by a proper degree of cutting and proper mixture of species with regard to their tolerance can help to bring about a desirable increase of soil temperature. Excessively heavy cuttings are, however, to be avoided.

Soil acidity has some influence on carbon dioxide production because it affects the activity of organisms in the soil. The average pH for the coniferous stands studied was found to be 4.5 and for hardwoods 5.1. In the case of conifers, higher acidities were found under young stands. For hardwoods the reverse was true—higher acidities being found under mature stands. In coniferous stands, the author found no correlation between acidity and carbon dioxide production. In hardwood stands he found the ratio of 109 to 82 in favor of the less acid soils.

Moisture content of the soil is another important factor. Carbon dioxide production can, in some instances, be increased by increasing the water content, especially of the drier soils. Here again proper degree of cutting offers the key to the problem.

The amount of litter and humus is another factor because this constitutes a source of food for micro-organisms which give off carbon dioxide as a by-product.

Type of vegetation on the forest floor has its influence on the rate of production. *Hypnum* and *Polytrichum* mosses are not harmful, nor are scattered herbs and grasses. Any tendency toward sod formation is detrimental.

The carbon dioxide content of forest air is about 0.04 per cent, while in the open it is invariably less, being usually about 0.03 per cent. The difference is due to the greater production of carbon dioxide of the soil in the forest which during the vegetative season averages approximately 10 grams per square meter

for every 24 hours. Meinecke found maximum values in the forest of 0.081 per cent and a minimum of 0.0205 per cent. The content at any one place of the air in a stand depends on the following: (1) carbon dioxide production of the soil; (2) withdrawal through assimilation; (3) addition through respiration of the crowns; (4) addition or diminution due to air movements; (5) diffusion.

The rate of production fluctuates daily as well as seasonally. Highest values are found at the time when soil and air temperatures are highest. For example, during a typical 24-hour period the values expressed in grams per square meter per day ranged from 17.6 grams to 8.0 grams, representing a fluctuation of 220 per cent. Precipitation may cause a rapid drop in the rate of production by cooling the upper layer of soil in which the carbon dioxide-producing organisms are most numerous and active.

There is a gradual change in production during the vegetative period from lows in spring to a peak in July, at which time the amount produced daily per square meter of soil surface may be from 15 to 20 grams. After July the rate drops off gradually.

Ordinarily, carbon dioxide content of the air is highest near the ground and decreases as the height above the ground at which samples are taken is increased. Often, however, Meinecke found higher values at a height of 1.5 meters above the ground than immediately above it. He believes that there is a possible correlation here with water content. From a height of 1.5 meters to the crowns, the carbon dioxide concentration decreases. Some exceptions to this rule occur when respiration of the crowns is at a maximum. In the crowns themselves there is a rapid falling off of carbon dioxide concentration up to the zone of the greatest number of assimilating organs of the leaves. Above that, it again rises. It is higher under the crowns than above them because most of the carbon dioxide used in assimilation comes from below, the soil being its source. If the content in the zone of the crowns drops below 0.03 per cent, some carbon dioxide may be assimilated from the air immediately above the crowns. This is the exception rather than the rule.

There seems to be no definite ratio or comparison in carbon dioxide production of hardwoods or conifers, or of young and old stands of the same species. The utilization of the amount available is as good in conifers as in hardwoods. Young stands of a given species are able to utilize it more completely than mature stands.

Wind generally causes a decrease in carbon dioxide content of the air in a forest. The amount available for the plant's use fluctuates with the average velocity of the wind. Hence, any silvicultural measures which can break the force of the wind are desirable. These include dense natural and artificial windbreaks around the main stand, two-storied forests, under planting, and others.

Diffusion is not very important, in the opinion of the author, in bringing about an interchange of carbon dioxide between the various strata of air. In the complete absence of wind, diffusion cannot bring about a high enough rate of interchange to supply the actual needs of the stand. This point is relatively unimportant because such a condition seldom exists for any great length of time in the average stand.

J. H. Stoeckeler,
Lake States Forest Experiment Station.

Vliv lesniho steliva na povrchovy odtok vod. (Influence of forest litter upon surface run-off). By

Bohuslav Maran. *Lesnicka Prace, IX, 1930. (Bohemia).*

A number of hydrologists and foresters believe that forest litter moderates the run-off only when the litter is partially saturated with water. They contend that completely saturated forest litter forms an imprevious body, which prevents the percolation of precipitation into the soil. Under such a condition forest litter does not moderate, but increases the run-off. Hence, this theory is usually advanced to explain the observations when run-off from a forested area exceeds the run-off from bare agricultural land.

The numerous investigations of the author largely disprove the above outlined hypothesis, yet at the same time they bring to light some new facts which are worth considering.

In Maran's laboratory experiments with forest litter, the maximum run-off has been observed when forest litter was perfectly dry. With increase of saturation of forest litter, the run-off decreased, up to a certain constant quantity. In the stage of a complete saturation, the forest litter did not disturb the percolation of water into the soil. However, in some cases a sudden addition of water to a completely saturated forest litter resulted in a run-off greater than the quantity of water which was added. This may be explained by the physical action of the water added, i.e., disturbance of saturative equillibrium, and the influence of adhesion forces.

In view of the foregoing, it is possible to expect in a region which has impervious mineral substratum, that a sudden heavy rain occuring after a long rainy period, may cause, for a short time at least, a larger run-off from the forested area than from non-forest land.

The author does not generalize from his observations. Instead, he is inclined to believe that in most cases the large run-off from forested areas is due to the fact that in mountainous regions the forest soils have usually thinner weathered layers of smaller water holding capacity is comparison with agricultural soils.

The experiments were carried out with different kinds of forest litter, under different gradients, and different temperatures. An unusual irregularity in water holding ability was observed with forest litter consisting of different mosses.

S. A. Wilde,
Madison, Wis.

Forest-Succession and Ecology in the Knysna Region. By John F. V. Phillips. *Botanical Survey of South Africa, Memoir No. 14. Pp. 327, plus 58 tables, 82 photographs, and 30 diagrams. 1931.*

The Knysna region on the south coast of Africa, is included in the temperate rain forest by Shantz and Marbut. Rainfall varies from approximately 30 to 50 inches per year, depending mainly upon the altitude, and is rather evenly distributed throughout the year.

After an ample consideration of geology, topography and soils, the author presents considerable data on climatic factors, and gives due attention to zoobiotic associates. The fauna are not grouped by communities, but a footnote explains that since the paper was written, the author has developed the biotic community concept of Clements and Shelford. Then follows the ordinary consideration of plant succession, with copious lists of plant species for each of the communities. After a discussion of the scrub and bush; the floristic features, constitution and structure of the high forests are presented. In the forests, which are of a decidedly mixed nature, the most important species appear to be *Olea laurifolia* and *Podocarpus thunbergii.* Domestic livestock are

not present in sufficient numbers to present any serious problems.

Several conclusions of silvicultural interest are brought out. Natural conditions in the forest can be improved without much alteration of the fundamental nature; undue rupture of the canopy must not be brought about because suitable degrees of illumination are favorable to regeneration, but excess opening of the stand is detrimental. A plan for thinning and lumbering is suggested for the Knysna forests, which includes preservation of the canopy wherever possible, and removal of over-mature salable trees, and even inferior species where they compete too severely with the better species for light, moisture and soil nutrients. It is interesting to note that the thinning of dense brush stands to allow for the establishment of new regeneration is considered good policy for the region. The studies show that except in brushy areas, the natural reproduction of the forest in its various stages is satisfactory, so that transplanting and seeding usually are not necessary. Where large trees have been felled, it is thought plausible to open up the soil under large chip deposits to let the new regeneration get a good start before soil acidity develops.

The author opposes the introduction of exotic plantings into the forest. For instance Blackwood (*Acacia melanoxylon*), was introduced to the indigenous forests on a silvicultural scale in 1909, with the objects of killing weed growth on exploited sites and assisting natural reproduction of native species. Observations showed that weeds were killed, but natural regeneration of tree species was either absent or poor under stands of the exotic, because of reduced light intensity and reduced soil moisture. It is suggested that planting of the species be discontinued within the forests as well as along the margins, although its introduction on burnt or exploited forest sites is considered advisable if no better quality forest is adjacent.

The report shows the results of a tremendous lot of field work, and is of interest for the ecological methods used. Naturally, it includes much detailed data of purely local application. Three appendices summarize certain features well, especially those of silvicultural interest.

R. S. Campbell,
Southwestern Forest and Range Experiment Station.

Outline of Forest Husbandry. (Grundriss der forstlichen Betriebswirtschafts lehre.) Dr. Gerhard Reinhold. *Paul Parey, Berlin. Pp. 213. 1931.*

The author is tutor at the University of Munich. He belongs to the younger school of foresters—those who have grown up since the war and are free from the hide-bound views of earlier generations. The book bears an untranslatable title: "Betrieb" is "Working;" "Wirtschaft" is "management" and "lehre" is "teaching." But to say that this is a book teaching "working management" is meaningless—or nearly so. The term "husbandry" comes nearer the meaning of the German "betriebswirtschaft."

And it is this new *husbandry* of the forest that the book sets forth in eminently readable style and (gloria Domino) latin typography. After a brief introduction which orients the subject as a part of forest management, the first half of the book deals with the *economics* of forest production in respect to:

1. Silvicultural considerations.
2. Capital.
3. Labor.
4. The market for forest products.

Then, the latter half of the book de-

scribes how forest production can be made *profitable*. This part includes the calculation of forest income and is a closely reasoned argument in favor of the soil rent theory.

The author concludes that soil rent calculations are essential for the correct determination of income. He claims that "the soil rent theory together with forest regulation (determination of the allowed cut) constitutes an entirely adequate basis for calculating the financial success of the forest business."

While much of this book is inapplicable to American conditions, it is refreshing to find the touchstone of commercial bookkeeping applied to forest production. The author in an almost dramatic epilogue inveighs against the extreme demands of sustained yield—calls it the handcuff of forest management. He holds with Judeich that sustained yield is not an essential of political economy but merely a policy which is adopted for reasons of political expediency. "Calculate, calculate, and again calculate," he cries—"and measure. That is the message which the teaching of forest husbandry brings . . . . having thus determined what *can* be done, it is the place of forest policy to determine what *shall* be done."

A. B. RECKNAGEL,
Cornell University.

Associations, Syndicats, et Sociétés Coopératives de Boisement (Associations, Syndicates and Cooperative Reforestation Societies). By Pierre Buffault. *Revue des Eaux et Forêts. Vol. 69, No. 9, September, 1931. Pp. 743-751.*

The article points out the deplorable limitations of the individual French woodland owner, whether it be a question of improvements, of fire protection, of management, of sale of his products, or even of simple supervision, just as the individual timber owner is handicapped in this country. Inheritance and dismemberment of property has acted unfavorably towards forest perpetuation. It is suggested that a certain portion of an estate be held for parcelment to heirs and the balance be invested with those societies whose purposes lead toward forest continuity. Such associations of wooded properties prevents their sale or their parcelling in case of death or change of proprietor.

The establishment of forest societies has been a relatively recent experiment. In the Dordogne region, for instance, no such organizations existed before 1907. Since then twenty or more have been formed mainly for the distribution of seed and seedlings and their planting, but also for limited improvement of existing wood-lots and the tapping of Maritime pine.

There are several different types of associations interested in concerted forestry practice. Some are distinctly professional, whose members freely get together for the study and defense of their interests. A declaration and the deposit of statutes at the local mayor's office by the association suffices to acquire the desired legal status.

In the coöperative society there is a subscription of capital stock in view of common operations. To be a member, it is necessary to subscribe for at least one share of stock. This is what distinguishes the coöperative from professional syndicates, where the members content themselves by paying annual dues. The capital of the coöperative society does not pay any dividends but merely a fixed rate of interest.

From an agricultural standpoint, there are several categories of coöperatives societies. The forestry coöperatives be-

long to the category of coöperatives for production and sale. Those which have for their objective solely reforestation are a special case of the category of coöperatives for production.

The coöperative for reforestation carries out the projects on land bought by its members. It manages and replenishes forests thus created and sells the wood for the profit of the society. The members must be agriculturists or landowners, among these latter may be admitted townships, public establishments, and owners of waste lands. But as it takes money as well as lands for reforestation, the stockholders are obliged to contribute money as well as land. Each member of a coöperative possesses, therefore, a certain number of shares of capital stock and a certain number of shares representative of the value of his land. He agrees to bring to the society for the whole duration fixed by the statutes, the full and entire ownership of the land which he wishes to reforest.

As soon as the revenues of the society permit, the interest must be paid to the owner of shares for the whole period. When the final cutting takes place, the society receives large sums which permits them to pay their debts, to set aside sinking funds to be used for replanting, if need be, to set aside 5 per cent for the legal reserve, and finally, to apportion the surplus among the members on the basis of shares representative of the value of the lands.

The society of limited responsibility is a special form of the anonymous society, a society with capital stock. It may be organized for any object whatever. With strictly commercial intent, it is subject to all the laws and uses of commerce. Shares can be paid in gold or in kind, and before the society can be formed. these shares must all be apportioned among the members. It appears as though such shares can be easily transfered from one to another. One advantage of this form of organization is that the tax on the revenue of personal property (stock) is not applicable to dividends, interest, and other products resulting from the administration of the society.

In addition to these associations and societies, there is considerable agitation afoot in forestry circles toward the organization of others for purely management purposes and sharing such benefits as are afforded.

Like individuals, forest societies participate in state subsidies and aid. Those founded solely for reforestation enjoy special fiscal immunities, i.e., if a certain society limits itself simply to selling the wood on the stump without the exploitations involving industrial operations, it is exempt from taxes on industrial and commercial profits. Coöperative societies may receive from the state long term advances at 2 per cent interest for a duration of from 25 to 50 years.

The forestry situation of the Department of Dordogne shows, as do those of Rougergue and the basque countries, that the associations are a future formula for the conservation of private woods and forests and for the reforestation in regions not too rugged, with soil more or less fertile and with the climate rather mild, i.e., the regions in which reforestation does not present difficulties of such a kind that the state alone is in a position to execute it.

In these regions, the type of society to be chosen cannot be determined in a general way in advance. It depends upon local conditions, the nature of the forests, the lands to be forested, and the mood of the owners. In order that the forestry societies may take the desired development and obtain all results that one can hope from them, it is necessary that the governments make certain legal and fiscal concessions.

A. B. Bowman,
Michigan State College.

Some Aspects of the Forest Tax Problem in Selected Towns of Wisconsin. By Daniel Pingree. *Progress Report No. 15, Forest Taxation Inquiry, U. S. Forest Service, New Haven, Connecticut. September 1, 1931.*

The object of the report is stated to be, "discovering to what extent the taxation of real estate has influenced this general lack of forestry practice, as well as to obtain such physical and tax data as might aid in testing alternative forest tax systems." Studies were made in 1926-27 in eight towns scattered throughout northern Wisconsin, in all of Lincoln county (also in the north) and in one town in the farm wood lot region of rough topography in the non-glaciated region of the southwestern part of the state. Since a bulletin on land use and taxation in Lincoln county had already been issued by the Wisconsin Experiment Station[1] the data from both sources were used in this report. Information was obtained on the present use and ownership of the unplatted real estate of these towns and six main property classes were established and three sub-classes. Changes in use and ownership in recent years were also noted. Information on the land, soil, and forest cover was obtained from local residents and by observation. Assessed values, taxes, sales and tax delinquency were obtained from public records. The investigators made their own appraisals of land and improvements to serve as a comparison with the assessed values on the same property. The figures are presented in a series of six tables for each town and for groups of towns for Lincoln county and for the county as a whole. Tables centering on certain facts present the data for selected towns and groups of towns, making a total of 99 tables.

Since the towns were chosen to include a variety of conditions, not all factors are comparable. However, the report shows a number of significant trends and facts.

1. An increase in operated farms between 1920-1926 in only a few places, but a great increase in abandoned farm land. A general marked decrease in the holdings of timber operators and the area of merchantable timber and a corresponding increase in the area of wild land.

2. Poor soils have the heaviest delinquency.

3. Where farm lands and merchantable timber predominate, tax delinquency is generally low. However, the policy of landowners is often an important factor. Timber owners may or may not let their timber lands and cut-over lands go delinquent. But there is heavy delinquency on the lands owned by real estate operators and "speculators."

4. There is a general tendency to assess all types of land on a uniform basis instead of differentiating between them.

5. With a few exceptions there has been a general decrease in the tax burden between 1920 and 1926.

6. There has been a general decline in assessed value of lands, but cut-over lands in general are assessed higher in proportion to the value ascertained by the investigators than other classes of property. Improvements had the lowest ratio of assessed to "true value." However, there was little evidence that the lands delin-

[1]Hibbard, B. H., Hartman, W. A., and Sparhawk, W. N., "Use and Taxation of Land in Lincoln County, Wisconsin." Agr. Exp. Station Bulletin 406 (1929). A series of extension circulars on "Making the Most of the Land" in Marinette, Ashland, Oneida, Taylor, and Forest Counties by the same station supplement the Report in many respects. Four of the towns covered by the Report are in these counties. See also Bulletin 100 of the Wis. Department of Agriculture and Markets, the "Land Economic Inventory of Bayfield County;" one of the towns covered by the Report is in this county.

quent were assessed higher than those not delinquent within the same class.

The cost of growing trees and the influence of the Forest Crop Law and other factors are presented for two towns. This report has little to say about the direct influence of taxation on the general lack of forestry practice; this is, no doubt, reserved for the final report.

George S. Wehrwein,
University of Wisconsin.

An Experimental Study of the Water Relations of Seedling Conifers with Special Reference to Wilting. By Robert Marshall. *Ecological Monographs 1:39-98. Duke Univ. Press, Durham, N. C. 1931.*

This paper deals with a set of very carefully conducted experiments on the behavior of tree seedlings during a period in which the soil was allowed to dry out. Particular objects of study were the moisture content of the seedling top during the drying period and the water-supplying power of the soil at critical wilting of the seedling.

The seeds were sown in quartz sand and placed in sheet iron flats. Seedlings which germinated early and late were removed from the bed. The plants were given normal watering until they were about 24 days of age, when watering was discontinued. On the day after the last watering, and daily thereafter, the seedlings were sampled for moisture content of the tops. All samples were taken in early morning, before sunrise, when the plants would have the greatest moisture content. Records of temperature and evaporation were kept throughout the growing and experimental periods.

At the beginning of the drying period the cotyledons were turgid and glossy with a tightly stretched epidermis. As the soil became drier the cotyledons lost their glossy appearance. Wrinkling of the epidermis followed together with twisting of the stems and cotyledons, which eventually became pale green and brittle. The stage at which definite epidermal wrinkles appear is called the critical phase of wilting and is believed to correspond with the "permanent wilting" phase used by Briggs and Shantz.

When the stage of critical wilting was reached, the moisture-supplying power of the soil was determined by use of Livingston porous-clay soil points. It is argued that this measurement has more physiological significance than measurement of soil moisture based on the volume or weight of the soil. For a uniform soil, such as was used in this study, there is a definite relationship between soil point readings and soil moisture determinations based on weight or volume of soil.

For Norway pine and Norway spruce, critical wilting occurred when the plants had lost about 15 or 20 per cent of their moisture content when healthy. For the 10 other species considerable variations occurred in the moisture content at critical wilting, which may possibly be more or less characteristic of the species. This factor also appeared to depend upon the amount of watering during the growing period, since seedlings which received deficient watering did not attain critical wilting until their moisture content was 76 and 79 per cent of optimum, whereas, plants receiving standard watering usually became critically wilted at 85 per cent of optimum moisture. Older seedlings had a much higher percentage of dry matter in the tops but wilted when they had lost about the same relative amount of water.

The trend of moisture content in the tops, as soil drying progressed, might be supposed to show an acceleration after the tensile water columns in the conductive tissue were broken, which would

probably occur just before death. The curves depicting rate of water loss do show definite acceleration following critical wilting in many cases, however, the phenomenon is not sufficiently prominent to serve as a basis for classification. In a number of cases a retardation of water loss preceded the acceleration, which evidently marked the period of stress before the columns broke.

One of the most interesting observations of the paper is the moisture-supplying power of the soil at critical wilting. For plants of the same species, receiving the same treatment, critical wilting occurred at a definite soil moisture content. Seedlings of Norway spruce, which had received excess watering during the growing period, became critically wilted when the initial water-supplying power of the soil was 59 milligrams per soil point per hour, while for those receiving standard watering this figure was 26 milligrams, and those with deficient watering 20 milligrams. Older plants maintained health with much lower soil moisture than young ones, the factor being 17 milligrams for 97 day old plants as compared with 26 milligrams for 24 day plants. This factor varied considerably with species and, since it is perhaps the best single measure the author gives of relative water requirements. the values are reproduced in Table 1.

It is to be expected that these figures will be considerably reduced as the plants grow older and may show some interchanges. It undoubtedly would be very valuable to have these measurements for seedlings which had attained planting or larger size. It is hoped the author may be privileged to continue these studies with older plant material.

HARDY L. SHIRLEY,
Lake States Forest Experiment Station.

TABLE 1

INITIAL WATER SUPPLYING POWER OF THE SOIL AT CRITICAL WILTING OF CONIFEROUS SEEDLINGS

Species	Age when watering was discontinued	Watering during growing period	Initial water supplying power of the soil at critical wilting Milligrams
Norway spruce	24 days	standard watering	26
Norway spruce	97 days	standard watering	17
Norway spruce	24 days	excess watering	59
Norway spruce	24 days	deficient watering	20
Norway pine	24 days	standard watering	19
Norway pine	24 days	deficient watering	12
White spruce	24 days	standard watering	30
Northern white cedar	24 days	standard watering	22
Short leaf pine	24 days	standard watering	12
Slash pine	24 days	standard watering	13
Western yellow pine	24 days	standard watering	11
Western white pine	24 days	standard watering	20
Douglas fir	24 days	standard watering	14
Lowland white fir	24 days	standard watering	14
Western red cedar	24 days	standard watering	14
Western hemlock	24 days	standard watering	25

SOCIETY AFFAIRS

Doings of the Executive Secretary

The Executive Secretary's monthly report to the members has been crowded out of the February and March Journals because the space was needed for papers, reports, resolutions, etc., emanating from the New Orleans meeting. In this, the April issue, there is room only for a few high-lights on the multifarious activities of three very full months.

ATTENDANCE AT SECTION MEETINGS

The Executive Secretary came home from New Orleans by way of Lake City, Florida, to attend the winter meeting of the Southeastern Section and to renew, or make new acquaintance, with the Society members in that part of the country.

January 29th-February 3rd, was spent in Raleigh and Durham, N. C., in attendance at the annual meeting of the Appalachian Section, in conference with Chairman J. V. Hofmann, concerning Society affairs in general, and with Dr. C. F. Korstian, Member of the Council in charge of admissions, in regard to the problems concerning new members.

February 11th-15th, was devoted to a trip to Arkansas to attend the annual meeting of the Ozark Section on February 12th at Fort Smith. Returned home via Hot Springs for further conference with William L. Hall, Chairman of the Ozark Section's membership committee, on membership and other Society matters.

February 26th-27th, in Baltimore at annual meeting of the Allegheny Section. Two of the Washington Section's regular monthly meetings were also participate in.

IMPORTANT QUESTIONS OF SOCIETY POLIC AND PROCEDURE LAID BEFORE THE SECTION

At all of these Section meetings oppor tunity was taken to sound out the sent ment of the membership on the severa questions of Society policy and practic now before the Council. The other Se tions not visited have been communicate with concerning these questions, by co respondence with their Chairmen. Th two most important of these question are:

1. The Allegheny Section's propose amendments of Section VII and VIII c the Constitution to provide a system c electing a Council that will be mor nearly sectionally or regionally represen tative.

2. The proposal from the Minneso Section that the eligibility rules for Fe low membership be more clearly define and the procedure for nomination an election to that grade be improved.

Both of these propositions invol amendment of the Constitution, a cun bersome, time consuming, and expensi process (See Article XIII of the Constit tion). Before submitting either of the to a referendum, the Council naturall wants to be reasonably sure that it unde stands and has interpreted correctly, t prevailing sentiment of the Society me bership. The advice therefore, of ind vidual members will be most welcome.

In this connection the possibility of a taining the desired end by the simpl

ocess of adoption by the Council of a w or amended by-law should be conlered. In some particulars failure to t the results wanted may be due merely the failure of the members themselves take advantage of their present constitional rights. Human nature oftentimes too prone, when it wants something ne differently, to urge the passage of a w law, when the old law, if we will ke the trouble to understand it, is adeuate. Maybe we foresters are only huan after all.

THE MEMBERSHIP MANUAL

This pamphlet is now in its final draft. has been re-written in accordance with structions given by the Council at New rleans and will shortly be presented to at body for its final approval. It will en be multicopied for distribution. In e preparation of this booklet several of e Sections and many individual memers have aided the Executive Secretary nd the Council materially. It has of ourse, taken time and labor to digest and oil down into acceptable form, all of the dvice and suggestions offered. But, the ork has been worthwhile because, we ow have, practically completed, a brief nterpretation of the membership eligibily rules, and a concise outline of the rocedure for the nomination and election f new members, as prescribed in the Constitution and By-Laws, which will be f material help to the Section officers nd individual members in putting up heir candidates, and to the Council itelf in casting its vote.

FEDERAL LEGISLATION

In between times the Executive Secreary has attended hearings before congresional committees and in correspondence with Sections, with Society members, and thers, to stimulate their interest in and support of those forestry measures in which the Society, as such, is particularly interested. Attention has been centered on the forest fire protection appropriations, for the National Forests and also for federal coöperation with the states, which Congress in its flare for economy has shown strong inclination to reduce below the point of safety; on the small item of $9,000.00 necessary to maintain a forestry observer, Arthur Ringland, in Europe; on the maintenance of the forest acquisition appropriation at the minimum essential to keep the organization together on Congressman Scott Leavitt's "Erosion Bill." Proposed legislation for the disposition of the Public Domain, and for re-organization of the Federal Executive Department have also been given attention.

Obviously the Executive Secretary has neither the time, the inclination, nor the authority to make a professional lobbyist of himself. He has functioned primarily as an expert witness for the Society on the urgent request of other organizations which recognize and value highly the weight and influence of the Society's professional opinion on questions of public forest policy.

NATIONAL PARK STANDARDS

Other spare moments have been given to the drafting of a statement of National Park standards, or principles, which might be adopted by the Society as a guide when asked to join in the support or opposition of some movement to create a new National Park. Consultations with the representatives of their organizations like the American Forestry Association and National Park Association, with our own President, and with Dr. John C. Merriam, one of our Honorary members, have been necessary.

National Parks, in the eyes of some members, may be a bit outside of the

proper field of the Society; but, requests for its coöperation are further evidence of the growing esteem of the Society and its judgment, and constitute responsibilities which for the sake of its own reputation, it can hardly evade. Moreover, some of the more recent proposed new National Parks raise questions concerning forest land ownership and administrative policy which come clearly within the scope of a body of professional foresters.

ROUTINE

The balance of the time, such as there is, has been taken up with handling the routine matters connected with the Executive Secretary's job. The handling of new membership cases has been an important activity during this portion of the year; correspondence with the Sections concerning their nominees and preparation of the cases for submission to the Council.

The entertainment of visitors is a part of the routine. The Society's office is coming more and more to be recognized as its headquarters and members from other parts of the country are dropping in with increasing frequency. Some of them have specific business to transact, others merely want to put their feet on the desk and talk the situation over. In either case, they are more than welcome and it is to be hoped that their numbers will steadily increase.

Franklin W. Reed,
Executive Secretary.

1932 Annual Meeting to Be in San Francisco

At the New Orleans meeting the Council desired that the 1932 annual meeting of the Society should be held on the West Coast and after considering the advantages of different places, decided that Sa Francisco is the best choice. The Ca fornia Section has acclaimed the choi and promises to do everything within i powers to insure a splendid meeting. D E. P. Meinecke has been selected Chairman of the Committee on Meetin and the list of the committee is now b ing selected.

C. M. Granger,
Presider

Appointment of Forest Policy Committees

The Forest Policy Committee in i final report made the following recon mendations:

"The Committee feels that it is ina visable to attempt to draw up a comple program based on all the principles, ar that greater progress will be made by s lecting a few of the more urgent matte and concentrating on them first. It is o vious that the whole strength of the S ciety brought to bear on a few points wi accomplish more than if spread over tl whole field. In putting any given princ ple into effect the first step is a progra and the second is action to put the pr gram into effect. We believe that the be results will be secured by the appoir ment of small committees of special qualified men to work out the progra for any principle which should be stresse and that each committee should present clear cut recommendation to the Preside of the Society."

The Council has approved the recor mendation as requested in the disban ment of the Forest Policy Committee wi hearty thanks for the very constructi work done, and the following committe have been asked to serve for the develo ment of programs of action, under the pri ciple indicated:

FIRE CONTROL

R. H. Chapler, *chairman,* Secretar

Oregon Forest Fire Association; Austin Cary, U. S. Forest Service; E. I. Kotok, Director, California Forest Experiment Station; F. W. Morrell, Assistant Forester, U. S. Forest Service; Harris Reynolds, Secretary, Massachusetts Forestry Association; Henry Schmitz, Division of Forestry, University of Minnesota; E. O. Siecke, State Forester, Texas; Lewis E. Staley, State Forester, Pennsylvania.

STABILIZATION OF THE FOREST INDUSTRY

S. T. Dana, *chairman*, Dean, Department of Forestry and Conservation, University of Michigan; R. E. Benedict, Manager, Brunswick Peninsula Co.; N. C. Brown, N. Y. State College of Forestry; S. V. Fullaway, Western Pine Association; Tom Gill, Pack Foundation; J. V. Hofmann, Department of Forestry, N. C. State College; R. S. Kellogg, Newsprint Service Bureau, N. Y.; B. P. Kirkland, Forest Economist, U. S. Forest Service; D. W. Martin, Timber Section, Bureau of Internal Revenue; T. D. Woodbury, Assistant Regional Forester, U. S. Forest Service.

PUBLIC FORESTS—PROTECTION FOREST ZONES

R. S. Hosmer, *chairman*, Depatrment of Forestry, Cornell University; H. L. Baker, State Forester, Florida; Geo. H. Cecil, Conservation Department, Los Angeles Chamber of Commerce; H. H. Chapman, Yale School of Forestry; W. B. Greeley, West Coast Lumbermen's Association; P. A. Herbert, Department of Forestry, Mich. State College; J. P. Kinney, Director, Division of Forestry, Bureau of Indian Affairs; J. C. Kircher, Regional Forester, U. S. Forest Service; Robert Marshall, Consulting Forester; Raphael Zon, Director, Lake States Forest Experiment Station.

COOPERATION TO IMPROVE EXPLOITATION PRACTICES

R. C. Bryant, *chairman*, Yale School of Forestry; A. J. Brandstrom, Logging Engineer and Forest Economist, U. S. Forest Service; H. L. Churchill, Finch, Pruyn and Company; W. J. Damtoft, Champion Fibre Co.; I. F. Eldredge, Forest Survey, U. S. Forest Service; Lee Muck, Assistant Director, Division of Forestry, Bureau of Indian Affairs; M. B. Pratt, State Forester, California; W. F. Ramsdell, Department of Forestry, University of Michigan.

PUBLIC CONTROL OF PRIVATE FOREST EXPLOITATION

H. S. Graves, *chairman*, Yale School of Forestry; Shirley W. Allen, Department of Forestry, University of Michigan; Swift Berry, Michigan-California Lumber Company; S. J. Hall, Consulting Forester, Jacksonville, Fla.; W. L. Hall, Consulting Forester, Hot Springs, Ark.; S. B. Locke, Director of Conservation, Izaak Walton League; C. K. McHarg, U. S. Forest Service, Idaho; W. N. Sparhawk, Forest Economist, U. S. Forest Service; R. Y. Stuart, U. S. Forest Service; J. B. Woods, Forester, Long-Bell Lumber Co.

C. M. GRANGER, *President.*

THIS COMPETITION FOR CREDIT

Honesty is the outstanding plank in the platform of forestry. Not one real forester would falsify a cruise or add or subtract from experimental data. However, is our policy or practice of giving due credit to others in our writings above reproach? It can be said without danger of contradiction that this error is not confined to foresters alone, but it can also be said that with the above basic principle we as foresters must be doubly cautious.

It is obvious that in this note names, publications and titles cannot be men-

tioned, but a few questions may be asked that point the way.

1. Is it ethical for a superior officer to appropriate the ideas of subordinates and attach his own name?

2. If the lower officer does all the field work and writes the manuscript which is reviewed and edited by the ranking officer is the superior the senior or junior author?

3. If even the lowest man in a field party develops a new method of illustration either by hand drawing or photography should not the chief of party give him credit by name for his assistance?

4. If a regional officer prepares an extensive manuscript on a particular project and for some reason it is not published, but later is consulted quite freely and ideas used in another region, would not the minimum of courtesy indicate the inclusion of the name of the man and the title of his manuscript in the bibliography of the later publication?

5. Should subordinate officers overlook their own development and future progress to further the "good" of the entire organization? Does this build for loyalty and high morale?

6. Isn't the credit given to a subordinate by a superior in a published article comparable to an increase in salary in honest satisfaction?

7. When all or most of the published material emanating from an organization carries the name of the chief does it not reflect upon that officer as not having worthy men on his staff?

T. J. Starker,
Oregon State College.

Editor's Note: Foresters cannot afford to permit their profession to condone plagiarism. Forestry was founded by paragons of altruism. It has been unselfish from the start, and must be kept so. There is glory enough for all.

Howard Rodgers Spelman
1899-1932

Promise of a brilliant career in forestry was terminated at Rockville Center, N. Y., in the death on January 26, 1932, of Howard Rodgers Spelman.

Spelman, a graduate forester, B. S. F., Syracuse, 1920, and M. F., Yale, 1922, and a Junior Member of the Society of American Foresters since 1924, had passed over the threshold of his usefulness. Thoroughly trained, experienced, possessing an exceptionally brilliant mind and a charming personality, his death, at the age of 32 years, results in a severe loss to the profession of forestry and to his many friends.

Howard Spelman was born November 17, 1899, at Rockville Center, N. Y. In 1919 he served as a Forest Assistant on the Montezuma Forest, Colorado, in 1920 with a pulp company in Quebec, in 1921 on engineering work with his father, John R. Spelman, in New York, entering the U. S. Forest Service as a Junior Forester in 1924. His first assignment was to timber sale work on the Santiam Forest, in Oregon. On July 10, 1925, he was transferred to the Snoqualmie Forest, Washington, and placed in charge of the Sauk River timber sale where his services as an administrative officer on timber sale work were outstanding.

Beginning July 16, 1926, Spelman left the Forest Service for a period of about a year in an attempt to forestall the attacks of a serious malady from which he was suffering. He returned to the Service on July 1, 1927, and was assigned to the Office of Forest Products in the Portland, Oregon, Regional Office.

The work in Forest Products appealed to Spelman's interest and his work on the various research projects to which he was assigned was of an exceptional quality. He was promoted on July 1, 1928, to the rank of Assistant Forester.

In September, 1930, Spelman suffered another physical breakdown, making it necessary for him on October 11, 1930, again to leave.

His death was not unexpected though it was a matter of great regret and sorrow to all of his friends. He leaves a widow, Mrs. Marion Vervoort Spelman, Rockville Center, N. Y.

Howard Spelman was universally liked for his friendliness and his many other admirable qualities as a man. His ability was outstanding and had he lived his training, thoroughness, energy, and outstanding intelligence and capacity would undoubtedly have carried him far in his chosen profession. His passing is a distinct loss to his many friends and to the cause of forestry.

ALLEN H. HODGSON,
U. S. Forest Service, Portland, Ore.

NEW ENGLAND SECTION HAS AMBITIOUS COMMITTEE PROGRAM

The Annual Winter Meeting of the New England Section was held at the Metropolitan District Commission Building, Boston, Massachusetts, on February 1 and 2, with an attendance of 118. The Committee on Forest Policy, H. H. Chapman, Chairman, was called on for the first report. The following subcommittees presented reports which were accepted: Stabilization of the Lumber Industry (R. C. Bryant); Acquisition of National, State and Municipal Forests (R. M. Ross); Coöperation of Federal and State Governments to Provide Adequate Protection Against Fire, Insects and Disease (W. O. Filley); Encouragement of Private Forestry through Tax Relief (H. O. Cook); Coöperative Control of Private Forests to Abolish Devastation through Federal or State Regulations (C. R. Tillotson); Public Education in Forestry (H. A. Reynolds). The Committee on White Pine Weevil Control (J. S. Boyce) presented its report which was accepted and the committee was discharged. The following committee reports were also given and the committees continued: Improvement of Stands (E. S. Bryant); Markets (E. C. Hirst); Wild Animal Damage (N. W. Hosley); Seed Certification (S. S. Lockyer); Foresters' Forest (K. W. Woodward). New committees to deal with forest insects, forest pathology and forest fires, their suppression and prevention were authorized. A subcommittee on blister rust was approved as a part of the Committee on Forest Pathology. After the banquet, which was held at the Boston City Club, Mr. R. E. Marsh, of the U. S. Forest Service, spoke on the extensive revision of the "Capper Report" and Mr. Ripley Bowman, Executive Secretary of the Timber Conservation Board, explained what this Board was doing. At the second session a resolution on the Leavitt amendment to the McNary-McSweeney Act was endorsed and sent to the Secretary of Agriculture and members of the Committee on Agriculture. A resolution on the Public Domain Bill was also endorsed and ordered sent to the New England Senators and Representatives. Dr. Perley Spaulding presented a paper on the Trunk Rots of Balsam Fir and Dr. R. B. Friend, Connecticut Agricultural Experiment Station, gave a paper on the European Pine Shoot Moth, which was augmented by lantern slides shown by A. H. MacAndrews of the New York State College of Forestry. H. P. Baker, Syracuse, R. S. Hosmer, Cornell, and W. G. Howard, New York Conservation Commission, were called on for short talks. Mr. A. C. Cline, Petersham, Massachusetts, was elected Chairman to succeed Mr. A. F. Hawes and Dr. H. J. MacAloney was reelected Secretary. Mr. H. J. Craig, Maine, and Mr. W. C. Shepard, Connecticut, were elected to the Executive Council for a term of three years.

H. J. MACALONEY,
Secretary, New England Section.

Forest Types Report Available

Reprints are now available of the article entitled "Forest Cover Types of the Eastern United States," commencing on page 451 of this issue. It is the final report of the Society's Committee on Forest Types.

The reprint is attractively bound with a green cover, and sells for 50 cents a copy. Orders should be sent to the Society of American Foresters, Hill Building, 839 17th St., N. W., Washington, D. C.

L. A. Warren,
Business Manager.

Adam Schwappach, 1851-1932

Dr. Adam Schwappach died in Eberswalde, Germany, on February 9, 1932. He had retired some years ago, as Director of the Forest Experiment Station at Eberswalde.

Dr. Schwappach was an honorary member of the Society.

Personals

Gordon T. Backus, U. S. Forest Service, and a member of the Allegheny Section, was shot near his home in Washington, D. C., on February 4, by a "sniper." Apparently, Mr. Backus was mistaken for a federal narcotic agent residing in his neighborhood. All efforts to locate the gunman have failed.

Mr. Backus' condition is much improved and he will return shortly to his office.

Inman F. Eldredge of the Superior Pine Products Co., has been chosen regional director of the Forest Survey in the South.

This work in the southern states is part of the nation-wide survey under the leadership of the Federal Forest Service

Announcement of Candidates for Membership

The following names of candidates for membership are referred to Junior Mem-
ers, Senior Members and Fellows for comment or protest. The list includes all
ominations received since the publication of the list in the March Journal, without
uestion as to eligibility; the names have not been passed upon by the Council. Im-
ortant information regarding the qualifications of any candidate, which will enable
he Council to take final action with a knowledge of essential facts, should be sub-
nitted before April 15, 1932, to the undersigned. Statements on different men should
e submitted on different sheets. Communications relating to candidates are consid-
red by the Council as strictly confidential.

FOR ELECTION TO GRADE OF JUNIOR MEMBER

Name and Education	*Title and Address*	*Proposed by*
Barney, Philip Yale, B. A., '29; M. F., '31.	Unemployed, Farmington, Conn.	New England Section
Breckenridge, Clarence G. N. Y. State College of Forestry, B. S., '30; Harvard Forest, candidate for M. F., '32.	Graduate Student, Harvard Forest, Petersham, Mass.	New England Section
Bird, Ronald L. Mich. State College, B. S. F., '27; U. of Mich., M. F., '30.	Estimator, Timber Survey, Chippewa N. F., Cass Lake, Minn.	Ohio Valley Section
Brandner, H. Phil. U. of Wash., B. S. F., '29; M. S. F., '30.	Ranger, Marquette N. F., Raco, Mich.	Ohio Valley Section
Cherry, Charles High School, 1 year; Salem Com. School, 1 year.	Supervisor, Myles Standish State Forest, South Carver, Mass.	New England Section
Craig, Johnston C. U. of Mich., B. S. F., '29; Yale, M. F., '31.	Unemployed. Romeo, Mich.	Ohio Valley Section
Drohomer, Michael J. U. of Mich., B. F., '31.	Wisconsin Land Economic Inventory, Madison, Wisconsin.	Ohio Valley Section
Falconer, Joseph G. U. of British Columbia, B. A. Sc.; Yale, M. F., 1929; completed Ph. D. prerequisite, 1931.	Research Assistant, Dept. of Chemistry and Soils, New Brunswick, N. J.	Allegheny Section
Faulks, Edward B. N. Y. State College of Forestry, B. S., '29.	Junior Forester, Forest Survey, Southern Forest Experiment Station, New Orleans, La.	Gulf States Section
Ferrari, George D. Mich. State, B. S. F., '30.	Junior Forester, Hiawatha N. F., Munising, Mich.	Wisconsin Section
Grant, Ralph M. U. of Mich., B. S. F., '31.	Student, U. of Michigan, Ann Arbor, Mich.	Ohio Valley Section
Hermel, Louis C. Mich. State, B. S. F., '30.	Student, Graduate School in Forestry, Michigan State, Traverse City, Mich.	Ohio Valley Section
Hyde, Gerald Randolph U. of N. H., B. S., '29.	Graduate Student, Harvard Forest, Petersham, Mass.	New England Section
Ilch, David M. Iowa State, B. S. F., '31.	Jr. Forester, Calif. Forest Exp. Sta., Berkeley, Calif.	California Section
Jobbett, Clayton C. Mich. State, B. S. F., '30.	Student, Graduate School of Forestry, Michigan State, Traverse City, Mich.	Ohio Valley Section
Jones, T. J. Grammar School; Business College. (For Reinstatement.)	Supervisor, Shasta N. F., Mount Shasta City, Calif.	California Section
Lehrbas, Mark M. U. of Idaho, B. S. F., '27.	Asst. Forest Economist, Southern Forest Experiment Station, New Orleans, La.	Gulf States Section

Name and Education	*Title and Address*	*Proposed by*
Lewis, Anselmo Univ. Calif., B. S. F., '30.	Jr. Forester, Calif. Forest Exp. Sta., Berkeley, Calif.	California Section
Patri, Carthon R. U. of Idaho, B. S. F., '21; 1 year towards M. S. F., '22.	Forest Supervisor, Colville Indian Reservation, Colville Agency, Nespelem, Wash.	North. Rocky Mtn. Sec.
Percey, Leslie S. 2 Yr. Course Bus. Management, LaSalle Extension Univ.; Special short course Forestry, U. C. L. A., '28; Special U. S. F. S. Ranger Course, Feather River, '29.	Firewarden Assistant, Los Angeles County Forestry Dept., Verdugo, Calif.	California Section
Priddle, John Frederick N. Y. State College of Forestry, Syracuse Univ., B. S. F., '31.	Unemployed, preparing for Jr. Forester Examination, 113 Bayswater Ave., Burlingame, Calif.	California Section
Smack, Lawrence C. Penn. State, B. S. F., '31.	Asst. Forester, Dept. of Conservation and Development, Trenton, N. J.	Allegheny Section
Sowash, Robert O. Mich. State, B. S. F., '31.	Student Assistant, Wood Technology Laboratory, Michigan State, East Lansing, Mich.	Ohio Valley Section
Stone, Leon H, Conn. Agric., B. S. F., '31.	Teaching Assistant, Penn. State, State College, Pa.	Allegheny Section
Wernham, John O. U. of Mich., M. F., '31.	Fire guard, Superior N. F., (eligible for J. F.), Marengo, Ill.	Ohio Valley Section
Ziebarth, Kurt Iowa State, B S. F., '31.	Research Assistant, Penn. State, State College, Pa.	Allegheny Section

FOR ELECTION TO GRADE OF SENIOR MEMBERSHIP

Gross, Lawrence S. Penn. State, B. S., '23. (Junior Member, 1924.)	Associate Regional Forest Inspector, Region 7, Washington, D. C.	Washington Section
Holdsworth, Robert P. Mich. State, B. S. F., '11; Yale, M. F., '28; Royal College of Forestry, Stockholm, Sweden. (Junior Member, 1929.)	Professor of Forestry, Mass. State College, Amherst, Mass.	New England Section
Wheeler, Gerald S. U. of Maine, B. S. F., '26; N. Y. State, M. F., '27. (Junior Member, 1927.)	Assistant Supervisor, White Mountain N. F., Laconia, N. H.	New England Section

FOR ELECTION TO GRADE OF ASSOCIATE MEMBER

Leavitt, Scott U. of Mich.	Member of Congress (Montana), Washington, D. C.	North. Rocky Mtn. and Washington Sections

C. F. Korstian,
Member of Council in Charge of Admission.

Elections to Membership

The following men have been elected to the grade of membership indicated.

APPALACHIAN SECTION

Junior Membership

Howell, Harold A.
Peck, Ralph Howard

Senior Membership

Maughan, William

NEW ENGLAND SECTION

Junior Membership

Holt, Reginald W.
Lane, George Richie
Monahan, Robert Scott
Plusnin, Basil A.

NORTH PACIFIC SECTION

Junior Membership

Arnst, Albert
Fullington, Floyd H.
Hiatt, Harlan C.
Rector, Charles M.
Wilkinson, John Christopher

SOUTHEASTERN SECTION

Junior Membership

Osborne, James G.

SOUTHWESTERN SECTION

Junior Membership

Roberts, Paul H.

Senior Membership

Bedford, J. M.

SOCIETY OFFICERS

Officers and Members of Council

President, C. M. Granger, Forest Service, Washington, D. C.
Vice-President, John D. Guthrie, Forest Service, Portland, Oregon.
Secretary-Treasurer, Paul G. Redington, Biological Survey, Washington, D. C.

Council

The Council consists of the above officers and the following members:

	Term expires		Term expires
Ralph S. Hosmer	Dec. 31, 1933	E. L. Demmon	Dec. 31, 1935
Clifton D. Howe	Dec. 31, 1933	A. F. Hawes	Dec. 31, 1935
Stuart B. Show	Dec. 31, 1933	C. F. Korstian	Dec. 31, 1935
Claude R. Tillotson	Dec. 31, 1933	Hugo Winkenwerder	Dec. 31, 1935

Member in Charge of Admissions

C. F. Korstian

Executive Officers

F. W. Reed, *Executive Secretary*
L. Audrey Warren, *Business Manager*
810 Hill Bldg., Washington, D. C.

Editor, Journal of Forestry

Emanuel Fritz, 231 Giannini Hall, Berkeley, Calif.

Section Officers

Allegheny

L. E. Staley, Acting Chairman, Secretary, Dept. of Forests & Waters, Harrisburg, Pa.
H. F. Round, Secretary, Forester's Office, Pa. R. R. Co., Philadelphia, Pa.

Appalachian

Dr. J. V. Hofmann, Chairman, N. C. State College, Raleigh, N. C.
J. H. Buell, Vice-Chairman, Appalachian Forest Experiment Station, Asheville, N. C.
I. H. Sims, Secretary, Appalachian Forest Experiment Station, Asheville, N. C.

California

William G. Durbin, Chairman, U. S. Forest Service, Susanville, Calif.
Myron E. Krueger, Vice-Chairman, 231 Giannini Hall, Berkeley, Calif.
Hubert L. Person, Secretary, 332 Giannini Hall, Berkeley, Calif.

Central Rocky Mountain

John H. Hatton, Chairman, U. S. Forest Service, Denver, Colo.
H. D. Cochran, Vice-Chairman, U. S. Forest Service, Denver, Colo.
Lynn H. Douglas, Secretary-Treasurer, U. S. Forest Service, Denver, Colo.

Gulf States

Fred B. Merrill, Chairman, State Forester, Jackson, Miss.
A. R. Spillers, Secretary, U. S. Forest Service, New Orleans, La.

Intermountain

Thornton G. Taylor, Chairman, Utah Agricultural College, Logan, Utah.
Arthur G. Nord, Vice-Chairman, U. S. Forest Service, Salt Lake City, Utah.
G. W. Craddock, Jr., Secretary, Intermtn. Forest & Range Exp. Sta., Ogden, Utah.

Minnesota

Prof. R. M. Brown, Chairman, Division of Forestry, University Farm, St. Paul, Minn.
Dr. H. L. Shirley, Secretary-Treasurer, Lake States Forest Exp. Sta., University Farm, St. Paul, Minn.

New England

A. C. Cline, Chairman, Harvard Forest, Petersham, Mass.
H. J. MacAloney, Secretary, Northeastern Forest Exp. Sta., Amherst, Mass.

New York

Hugh P. Baker, Chairman, College of Forestry, Syracuse, N. Y.
H. C. Belyea, Secretary, College of Forestry, Syracuse, N. Y.

Northern Rocky Mountain

D. S. Olson, Chairman, U. S. Forest Service, Missoula, Mont.
C. K. McHarg, Vice-Chairman, U. S. Forest Service, Coeur d'Alene, Idaho.
I. T. Haig, Secretary, N. Rocky Mt. For. Exp. Sta., Missoula, Mont.

North Pacific

L. F. Cronemiller, Chairman, State House, Salem, Ore.
R. E. McArdle, Secretary-Treasurer, 514 Lewis Bldg., Portland, Ore.

Ohio Valley

R. B. Miller, Chairman, Div. of Forestry, State Capitol Bldg., Springfield, Ill.
T. E. Shaw, Secretary-Treasurer, Purdue University, Lafayette, Ind.

Ozark

H. R. Koen, Chairman, Russellville, Ark.
Glen Durrell, Vice-Chairman, Okla. Forest Service, Broken Bow, Okla.
Charles A. Gillett, Secretary, Extension Service, Little Rock, Ark.

Southeastern

S. J. Hall, Chairman, 1412 Barnett Natl. Bank Bldg., Jacksonville, Fla.
E. W. Hadley, Vice-Chairman, Lake City, Fla.
W. H. Moore, Secretary-Treasurer, c/o James D. Lacey Co., Jacksonville, Fla.

Southwestern

Quincy Randles, Chairman, Forest Service, Albuquerque, N. Mex.
D. A. Shoemaker, Vice-Chairman, U. S. Forest Service, Albuquerque, N. Mex.
Stanley F. Wilson, Secretary, U. S. Forest Service, Albuquerque, N. Mex.

Washington

H. A. Smith, Chairman, U. S. Forest Service, Washington, D. C.
C. Stowell Smith, Vice-Chairman, Natl. Lumber Mfrs. Assoc., Transportation Bldg., Washington, D. C.
Alfred E. Fivaz, Secretary, Bureau Plant Industry, Washington, D. C.

Wisconsin

H. Basil Wales, Chairman, U. S. Forest Service, Milwaukee, Wis.
A. G. Hamel, Secretary, 2618 N. 61st St., Milwaukee, Wis.